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MRP Rs 740.00

Published by :
PAPERGPT
125, Sector 6, Vidyadhar Nagar, Jaipur 302039
Phone :+91 9001005245

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02 AGRICULTURAL ENTOMOLOGY

Unit 1: Systematics

History and development of Entomology, Evolution of insects, position of insects in the animal world, characteristics of phylum Arthropoda, structural features of important arthropod groups such as Trilobita, Chelicerata and Mandibulata, structural features of important classes of phylum Arthropoda viz. Arachnida, Crustacea, Chilopoda, Dip lopoda and Hexapoda. Classification of insects up to order level, habits, habitats and distinguishing features of different Order and important Families. DNA barcoding, Phylogenetic analysis.

Unit 2: Morphology

Body wall, its structure, outgrowths, endoskeleton, Body regions, segmentation, sclerites and sutures. Head and head appendages, types of mouth parts, antennae, their structure and types. Thorax structure, thoracic appendages and their modification. Wings, their modification and venation, Abdomen; structure, abdominal appendages both in Pterygota and Apterygota.External genitalia, general structure and modification in important insect orders.

INDIA

Unit 3: Embryology, Internal Anatomy and Physiology

Embryonic and post embryonic development, types of metamorphosis, physiology of ecdysis. General features and types of larvae and pupae. Structure, function and physiology of Digestive, Circulatory, Respiratory, Reproductive, Nervous and Excretory systems, Sense Organs; structure and types. Insect food and nutrition; minerals, carbohydrates, proteins and amino acids, lipids, vitamins and their role in growth and development, artificial diets.

Unit 4: Ecology

Concept of ecology, Environment and its components-biotic and abiotic factors and their effects on growth, development, population dynamics, distribution and dispersal. Principle of biogeography and insects' biodiversity. Biotic potential and environmental resistance. Ecosystems, agroecosystems analysis, their characteristics and functioning. Intra and inter specific relationship; competition, predator-prey and host parasite interactions, ecological niche. Life table studies, population models. Food chain and food web. Arthropod population monitoring, pest forecasting. Diapause and causes of pest outbreaks.

Unit 5: Biological Control

Importance and scope of biological control, history of biological control: Biocontrol agents-parasites, predators and insect pathogens. Important entomophagous insect Orders and Families. Ecological, biological, taxonomic, legal and economic aspects of biological control,phenomena of multiple parasitism, hyper parasitism, super parasitism and their applied importance. Principles and procedures of using exotic biocontrol agents. Utilization of natural biocontrol agents: conservation, habitat management and augmentation. Mass multiplication techniques and economics. Effective evaluation techniques, Biocontrol organizations in world and India. Successful cases of biological control of pests.

Unit 6: Chemical Control and Toxicology

History, scope and principles of chemical control. Insecticides and their classification. Formulations of insecticides. Susceptibility of insects to the entry of insecticides. Physical, chemical and toxicological properties of different groups of insecticides: chlorinated hydrocarbons, organophosphates, carbamates, synthetic pyrethroids, chlordimeform, chitin synthesis inhibitors, avermectins, nitroguandines, phenylpyrrozzoles, botanicals (natural pyrethroids, rotenone, neem products, nicotine, pongamia spp. etc). Combination insecticides.Problems of pesticide hazards and environmental pollution. Safe use of pesticides, precautions and first aid treatments. Insecticides Act 1968, registration and quality control of insecticides. Evaluation of toxicity, methods of toxicity testing, determination of LD50, LT50, RL50 etc, Pesticide management Bill, 2020. Pesticides residues in the environment and their dynamics of movements, methods of residue. Codex, FSSAI, HACCP, Pharmacology of insect poisons. Mode of action of different groups of insecticides; neuroactive (axonal and synaptic) poisons, respiratory poisons, chitin synthesis inhibitors. Metabolism of insecticides; activative and degradative metabolism, detoxification enzymes and their role in metabolism. Selectivity of insecticidal actions; insecticide resistance; mechanism, genetics and management of insecticide resistance.

Unit 7: Host Plant Resistance
Chemical ecology: mechano and chemo receptors. Host plant selection by phytophagous insects. Secondary plant substances and their defenses against phytophagous insect. Basis of resistance (Antixenosis, Antobiosis, Tolerance). Biotypes development and its remedial measures. Tritrophic interactions, induced resistance. Breeding for insect resistant plant varieties. Resistance development and evaluation techniques. Genetics of Resistance: vertical resistance, horizontal resistance, oligogenic resistance, polygenic resistance. Biotechnological approaches and development of transgenic insect resistant plants, its advantages and limitations. Case histories. Insect resistance to transgenic plants and its management.

Unit 8: Innovative Approaches in Pest Control
Behavioral control: pheromones-types and uses, advantages and limitations. Hormonal control: types and function of insect hormones, insect hormone mimics, advantages and limitations. chemosterilants, antifeedants, attractants, repellents; their types, method of applications, advantages and limitations. Genetic control: concepts and methods, case histories, advantages and limitations. Potentialities of IPM; molecular approaches for developing insect pest management strategies (RNAi, CRISPR).

Unit 9: Integrated Pest Management
History, concept and principles of IPM. Components of IPM: Host plant resistance, agronomic manipulations, mechanical and physical methods, chemical methods, biocontrol agents utilization, genetic and behavioral control strategy etc. IPM strategies for field and horticultural crops. IPM case histories. Concept of damage levels-Economic threshold levels (ETL), Economic injury levels (EIL) and their determination. System approach, Agro ecosystem and cropping system vs. IPM. Constraints and Strategies of IPM implementation.

Unit 10: Pesticide Application Equipments
Types of appliances: sprayers, dusters, fog generators, smoke generators, soil injecting guns, seed treating drums, flame throwers, etc. Power operated sprayers and dusters. Types of nozzles and their uses. Maintenance of appliances. Aerial application of pesticides, principles of aerial application, factors affecting the effectiveness of aerial application. Equipments for aerial applications. Advantages and disadvantages of aerial application.

Unit 11: Pests of Field Crops and their Management
Distribution, host range, biology and bionomics, nature of damage and management ofarthropod pests of cereals, Oilseed, pulses and fibre crops, sugarcane and tobacco. Polyphagous pests: locusts, termites, hairy caterpillars, cut worms and white grubs.

Unit 12: Pests of Horticultural Crops and their Management
Distribution, host range, biology and bionomics, nature of damage and management ofarthropod pests of vegetables, fruits and plantation crops, spices, condiments and ornamentals.

Unit 13: Pests of Stored Products and their Management
Fundamentals of storage of grains and grain products. Storage losses, sources of infestation/infection, factors influencing losses, insect and non-insect pests, their nature of damage and control. Microflora in storage environment and their control. Storage structures,bulk storage and bag storage, their relative efficacy and demerits. Grain drying methods and aeration. Non-insect pests (rodents, birds, mites) of stored products and their control. Integrated management of storage pests.

Unit 14: Arthropod Vectors of Plant Diseases
Common arthropod vectors *viz.* aphids, leaf hoppers, plant hoppers, whiteflies, thrips, psylids, beetles, weevils, flies, bees and mites and their relationship with the plant pathogenic fungi, bacteria, viruses, mycoplasma. Mechanism of pathogen transmission: Active mechanical transmission, biological transmission. Toxicogenic insects, mites and phytotoxemia. Some important arthropod vector transmitted diseases and their epidemiology in India. Management of vector and its effect on control of diseases.

Unit 15: Honey Bees and Bee-keeping
Honey bees and their economic importance. Bee species, their behaviour, habit and habitats. Bee Keeping: bee pasturage, hives and equipments, seasonal management. Bee enemies inducing diseases and their control.

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Unit 16: Silkworms and Sericulture
Silkworm species, their systematic position and salient features. Rearing techniques of mulberry-muga-eri and tassar silkworms. Nutritional requirements of silkworms. Sericulture: rearing house and appliances, silkworm breeds, principles of voltism and nioultism, seed production and its economics. Enemies and diseases of silkworms and their management. Sericulture organization in India.

Unit 17: Lac Insect
Lac insect, its biology, habit and habitats. Host Trees: pruning, inoculation, lac cropping techniques, and harvesting. Enemies of lac insect and their control.

Unit 18: Other Useful Insects
Pollinators, biocontrol agents of weeds, soil fertility improving agents, scavengers. Use of insects and insect products in medicines. Usefulness of insects in scientific investigations, insects as food.

Unit 19: Statistics and Computer Application
Frequency distribution, mean, mode and median. Standard, normal, bionomial and Poisson's distribution, Sampling methods and standard errors. Correlation and regression: Partial and multiple, tests of significance; t, F, chi-square, Duncan's multiple range tests. Design of experiments: Principles of Randomized block design, completely randomized block design, Latin square design, Split-plot designs. Probit analysis.

NODIA

CHAPTER 01
Systematics

2019

1. Which of the following global pioneers in entomological history is credited with classifying insects into 'Pterota' (winged) and 'Aptera' (wingless)?
(A) Pliny the Elder
(B) Aristotle
(C) Carolus Linnaeus
(D) Johan Christian Fabricius

2006

2. Which of the following is an INCORRECT statement regarding the foundational contributions of early entomologists?
(A) Pliny the Elder compiled vast amounts of biological data in his work Historia Naturalis.
(B) Carolus Linnaeus introduced the binomial system of nomenclature for all animals, including insects, in Systema Naturae.
(C) Aristotle observed and documented the life cycle stages of certain insects, differentiating between grubs and adults.
(D) Johan Christian Fabricius based his primary classification of insects on the structural variation of their wings.

2018

3. Which of the following publications is considered the starting point of zoological nomenclature under the International Code of Zoological Nomenclature (ICZN)?
(A) Linnaeus's Systema Naturae, 10th Edition (1758)
(B) Fabricius's Systema Entomologiae (1775)
(C) Pliny's Historia Naturalis (77 AD)
(D) Aristotle's Historia Animalium (350 BC)

2005

4. What was the primary criteria used by Johan Christian Fabricius to classify insect orders?
(A) The presence or absence of a pupal stage
(B) The comparative morphology of the thorax
(C) The type and structure of insect mouthparts
(D) The structure and venation of the wings

2017

5. Consider the following statements regarding global entomological pioneers:
I. Linnaeus classified insects into exactly ten orders based exclusively on their habitat.
II. Fabricius was a student of Linnaeus and heavily emphasized maxillary structure in taxonomy.
III. Aristotle recognized the division of insects based on the presence of membranous versus modified forewings.
Which of the above statements are correct?
(A) I and II
(B) II and III
(C) Only II
(D) Only III

2018

6. How did the establishment of the Indian Museum in Calcutta (1814) primarily influence the early history of Indian entomology?
(A) It initiated the very first quarantine regulations for managing exotic agricultural pests.
(B) It led directly to the formation of the Entomological Society of India within that decade.
(C) It was dedicated to research concerning medical entomology and local malaria vector control.
(D) It served as the central repository for collections used in systematic taxonomic studies.

2006

7. Who served as the first Imperial Entomologist of India and authored the comprehensive book "Indian Insect Pests" in 1906?
(A) T.B. Fletcher
(B) H.M. Lefroy
(C) Lionel de Niceville
(D) M.S. Mani

2007

8. Identify the INCORRECT pair regarding key figures in Indian entomology and their major contributions.
(A) H.M. Lefroy - Indian Insect Life
(B) T.B. Fletcher - Some South Indian Insects
(C) E.P. Stebbing - First Imperial Entomologist

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of India
(D) Lionel de Niceville - Taxonomy of Indian butterflies

2019

9. Which exception correctly completes the rule: All of the following are valid requirements for an available taxonomic name under the ICZN, EXCEPT:
(A) It must be published in a widely accessible scientific medium.
(B) It must be accompanied by a description or definition that states in words characters that are purported to differentiate the taxon.
(C) It must be spelled using only the 26 letters of the Latin alphabet.
(D) It must be consistently applied using a trinomial format for generic designations.

2015

10. Read the following statements and choose the correct option:
Assertion (A): Under ICZN rules, a junior synonym can never replace a senior synonym under any circumstances.
Reason (R): The Principle of Priority dictates that the oldest available name applied to a taxon is the valid name.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2017

11. If a newly discovered insect population is morphologically indistinguishable from an existing species but is reproductively isolated in natural conditions, which species concept justifies classifying it as a distinct species?
(A) Typological Species Concept
(B) Biological Species Concept
(C) Morphological Species Concept
(D) Phylogenetic Species Concept

2009

12. According to the ICZN, what is the specific term for a single specimen designated or otherwise fixed as the name-bearing type of a nominal species or subspecies when the nominal taxon is established?
(A) Holotype
(B) Paratype
(C) Neotype
(D) Syntype

2007

13. Which scenario most accurately represents the application of the Principle of Homonymy in zoological nomenclature?
(A) Two different species in the same genus are mistakenly given the exact same specific epithet.
(B) A single species is given two different names by two independent researchers in the same year.
(C) A newly described genus lacks a designated type species.
(D) A junior synonym is elevated to valid status due to a morphological revision.

2012

14. What is the fundamental premise of the Symphylan theory regarding the evolutionary origin of insects?
(A) Insects evolved directly from a marine crustacean ancestor via the development of a carapace.
(B) Insects derived from a specialized annelid worm through the gradual sclerotization of the cuticle.
(C) Insects and symphylans share a common terrestrial ancestor with similar labial structures.
(D) Insects evolved from a flying ancestor that secondarily lost wings to become symphylans.

2005

15. Consider the following statements concerning the Pancrustacea theory:
I. It posits that Hexapoda and Crustacea form a monophyletic group.
II. Molecular data, including mitochondrial COI genes, strongly refute this theory.
III. It suggests that hexapods emerged as a terrestrial branch within the crustacean clade.
IV. It asserts that hexapods are more closely related to myriapods than to any crustacean lineage.
Which of the above statements are correct?
(A) I and III
(B) I, II and III
(C) II and IV
(D) I, III and IV

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2006

16. Which morphological feature was historically used to support the Annelid theory of arthropod origins, despite modern molecular refutation?
(A) The presence of a chitinous exoskeleton and jointed appendages
(B) The development of specialized tracheal respiratory systems
(C) The shared trait of metameric segmentation and a ventral nerve cord
(D) The identical structure of the ommatidia in the compound eyes

2007

17. Why is the fossil insect Rhyniognatha hirsti evolutionarily significant?
(A) It provides the first conclusive fossil evidence of complete metamorphosis.
(B) It possesses dicondylic mandibles, suggesting true insects existed by the early Devonian period.
(C) It is the earliest known fossil with fully developed wings, proving flight originated in the Devonian.
(D) It is the only known fossil linking trilobites directly to modern dipterans.

2023

18. What was a defining morphological characteristic of the extinct insect order Palaeodictyoptera?
(A) The complete absence of prothoracic lobes in both the nymphal and adult stages.
(B) A highly modified, sclerotized ovipositor adapted for endoparasitism in plants.
(C) Hardened elytra-like forewings covering membranous hindwings for protection.
(D) Beaked piercing-sucking mouthparts and prothoracic winglets.

2022

19. Which of the following is a correct statement regarding the evolutionary impact of the Permian-Triassic extinction event on insects?
(A) It caused a bottleneck, extinguishing primitive orders like Palaeodictyoptera.
(B) It caused the total extinction of the Neoptera, leaving only Paleoptera to repopulate the earth.
(C) It had negligible impact on insect diversity due to their highly adaptable tracheal systems.
(D) It triggered the immediate evolutionary split between Entognatha and Ectognatha.

2017

20. Match the evolutionary theories of insect origin in List I with their key characteristics or proponents in List II:
List I: Evolutionary Theories
P. Symphylan theory
Q. Pancrustacea theory
R. Annelid theory
S. Hexapod polyphyly
List II: Characteristics or Proponents
1. Suggests independent terrestrial adaptations of different hexapod lineages
2. Supported heavily by modern molecular phylogenetics
3. Historically proposed based on homologies in segmentation and nervous systems
4. Imms suggested a close link via head structure and epicranial sutures
(A) P-1, Q-2, R-3, S-4
(B) P-4, Q-3, R-2, S-1
(C) P-4, Q-2, R-3, S-1
(D) P-3, Q-1, R-4, S-2

2002

21. Which general physiological characteristic strictly defines the circulatory system of the Phylum Arthropoda?
(A) An open system where hemolymph bathes internal organs directly within the haemocoel
(B) A closed system utilizing solely hemoglobin as a respiratory pigment
(C) A semi-closed system with distinct capillary networks in the appendages
(D) An open system heavily reliant on hemocyanin for efficient carbon dioxide transport in terrestrial forms

2003

22. Identify the INCORRECT statement regarding the general characteristics of the Phylum Arthropoda.
(A) Growth occurs through a process of ecdysis mediated by the hormone ecdysone.
(B) The exoskeleton is composed primarily of a nitrogenous polysaccharide called chitin.
(C) Striated muscles are attached directly to the internal surfaces of the exoskeleton.
(D) The nervous system is characterized by a dorsal brain connected to a dorsal nerve cord.

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2021

23. What primary evolutionary advantage does tagmosis confer to arthropods?
(A) It allows for continuous growth without the

need to shed the exoskeleton.
(B) It allows for specialization of body regions for distinct biological functions.
(C) It enables the organism to switch between open and closed circulatory systems based on environmental stress.
(D) It provides a mechanism for asexual reproduction through spontaneous body segmentation.

2023

24. Which feature is absent in all known members of the subphylum Trilobitomorpha?
(A) A distinctly segmented body divided into a cephalon, thorax, and pygidium
(B) Biramous appendages present on almost all body segments
(C) True mandibles adapted for biting and chewing
(D) A pair of pre-oral antennae

2009

25. Consider the following statements concerning the diagnostic structural features of Trilobitomorpha:
I. They possessed a highly developed tracheal system for terrestrial respiration.
II. The body was divided longitudinally into a central axial lobe and two lateral pleural lobes.
III. Their appendages were typically uniramous, adapted exclusively for benthic crawling.
IV. They are an extinct subphylum that dominated marine ecosystems during the Paleozoic era.
V. They lacked compound eyes entirely, relying instead on simple ocelli.
Which of the above statements are correct?
(A) I, II and IV
(B) II, IV and V
(C) II and IV
(D) I, III and V

2015

26. What distinguishes the primary mouthparts of the subphylum Chelicerata from those of the Mandibulata?
(A) Chelicerates use pre-oral chelicerae while mandibulates use post-oral mandibles.
(B) Chelicerates possess pedipalps that function as jaws, whereas mandibulates use chelicerae.
(C) Chelicerates have heavily sclerotized maxillae, while mandibulates have soft, fleshy palps.
(D) Chelicerates lack mouthparts entirely, absorbing nutrients cuticularly, unlike mandibulates.

2002

27. Which of the following is a correct pair representing an agriculturally important family within the Class Arachnida and its primary feeding habit?
(A) Phytoseiidae - Obligate plant parasites
(B) Tetranychidae - Phytophagous sap-feeders
(C) Ixodidae - Nectarivorous pollinators
(D) Araneidae - Endoparasitoids of lepidopteran larvae

2014

28. Which characteristic is typically observed in the Class Arachnida but is exceptionally modified or absent in the Order Acari (mites and ticks)?
(A) A prosoma and opisthosoma that are not broadly fused.
(B) The presence of exactly four pairs of walking legs in the adult stage.
(C) The reliance on chelicerae for piercing or grasping prey.
(D) The lack of true antennae on the anterior body region.

2006

29. What is the most relevant anatomical basis for differentiating subphylum Mandibulata from Chelicerata regarding sensory structures?
(A) Mandibulates possess antennae, whereas chelicerates inherently lack them.
(B) Mandibulates always possess compound eyes, whereas chelicerates only possess simple eyes.
(C) Mandibulates have sensory pedipalps, which are completely absent in chelicerates.
(D) Mandibulates utilize Johnston's organ on their legs, whereas chelicerates have it on their head.

2022

30. Which trait provides strong comparative evidence distinguishing Class Chilopoda from Class Diplopoda?
(A) Chilopods are primarily detritivorous, whereas diplopods are obligate predators.
(B) Chilopods have two pairs of legs per body segment, whereas diplopods have one pair.
(C) Chilopods possess modified first trunk appendages called venom claws.
(D) Chilopods lack antennae and compound eyes, both of which are prominent in diplopods.

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2012

31. Identify the INCORRECT statement regarding the economic importance of crustaceans, chilopods, and diplopods.
(A) Some terrestrial isopods (Crustacea) can occasionally become minor pests of greenhouse seedlings.
(B) Many marine crustaceans are of immense global economic value as a primary human food source.
(C) Chilopods are generally beneficial in agricultural settings as they predate on various soil-dwelling insect pests.
(D) Diplopods are universally highly venomous and pose a significant direct threat to livestock.

2022

32. Which of the following defines a strict synapomorphy of the Class Hexapoda?
(A) The presence of biramous appendages on the thoracic segments
(B) The complete fusion of the maxillae to form a single continuous labrum
(C) A body divided into exactly three tagmata: head, thorax, and abdomen
(D) The utilization of hemocyanin as the primary oxygen carrier in the hemolymph

2008

33. Why is the structure of the hexapod thorax considered a defining structural characteristic in arthropod evolution?
(A) It developed specialized spiracles that actively pump air into the closed circulatory system.
(B) It consolidated locomotive appendages into three segments with uniramous legs.
(C) It merged completely with the cephalic region to form a rigid cephalothorax optimized for flight.
(D) It houses the primary digestive organs, freeing the abdomen exclusively for reproduction.

2017

34. What morphological feature acts as the primary taxonomic divider between the classes Entognatha and Ectognatha?
(A) The presence or absence of a developed furcula
(B) The number of functional spiracles on the abdominal segments
(C) The presence of dicondylic versus monocondylic mandibles
(D) The enclosure of the mouthparts within a cranial gnathal pouch.

2011

35. Select the correct evolutionary sequence reflecting the emergence of major arthropod/hexapod anatomical features, from most basal to most derived:
(A) Biramous appendages → Entognathy → Dicondylic mandibles → Wings
(B) Dicondylic mandibles → Biramous appendages → Entognathy → Wings
(C) Entognathy → Biramous appendages → Wings → Dicondylic mandibles
(D) Wings → Entognathy → Dicondylic mandibles → Biramous appendages

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2005

36. Which of the following is a correct statement detailing the characteristics of the order Collembola?
(A) They possess long, multi-segmented cerci used primarily for sensory perception in deep soil.
(B) They exhibit complete metamorphosis, featuring a distinct pupal stage in the soil.
(C) Their abdomen consists of exactly six segments and usually bears a ventral tube (collophore).
(D) They possess prominent compound eyes and fully developed functional wings in the adult stage.

2025

37. Which entognathous order is uniquely characterized by anamorphosis, where segments are added to the abdomen during successive molts?
(A) Protura
(B) Diplura
(C) Collembola
(D) Thysanura

2022

38. All of the following are general characteristics of the Subclass Apterygota EXCEPT:
(A) They are primarily wingless.
(B) They undergo ametabolous development.
(C) They often retain pregenital abdominal appendages like styli.
(D) They possess an internal gnathal pouch enclosing their mouthparts.

2007

39. How do members of the order Archaeognatha (jumping bristletails) predominantly differ

structurally from the order Zygentoma (silverfish)?
(A) Archaeognatha are entirely blind and possess dicondylic mandibles.
(B) Archaeognatha possess monocondylic mandibles and large contiguous compound eyes.
(C) Archaeognatha lack abdominal styli, which are highly developed in Zygentoma.
(D) Archaeognatha have specialized wings for short gliding, whereas Zygentoma are completely apterous.

2025

40. Read the following statements and choose the correct option:
Assertion (A): The subclass Pterygota is monophyletic, indicating that insect flight evolved only once in history.
Reason (R): All winged insects and their secondarily wingless descendants share homologous wing articulation structures and a comparable network of tracheation.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2016

41. What is the fundamental functional difference distinguishing the division Neoptera from Paleoptera?
(A) Neopterans undergo complete metamorphosis, whereas paleopterans undergo incomplete metamorphosis.
(B) Neopterans utilize indirect flight muscles exclusively, whereas paleopterans utilize only direct flight muscles.
(C) Neopterans possess membranous wings, while paleopterans possess heavily sclerotized elytra.
(D) Neopterans can fold their wings flat over their abdomen at rest using specialized axillary sclerites.

2005

42. Identify the INCORRECT statement regarding the major evolutionary divisions of Subclass Pterygota.
(A) The order Ephemeroptera is uniquely classified as a neopteran insect with ametabolous development.
(B) The order Odonata belongs to the division Paleoptera.
(C) The division Neoptera encompasses both exopterygote and endopterygote lineages.
(D) Paleopteran insects lack the third axillary sclerite and associated pleural muscle needed for wing folding.

2022

43. Which of the following physiological processes most directly underpins the classification of insects into Exopterygota versus Endopterygota?
(A) The method of nitrogenous waste excretion via Malpighian tubules versus nephridia
(B) The internal versus external development of wings during the immature stages
(C) The development of external reproductive appendages (genitalia) before versus after the final molt
(D) The location of primary sensory receptors on the antennae versus the tarsi

2011

44. What defines the primary morphological and developmental characteristics of the Exopterygota (Hemimetabola)?
(A) Nymphs that generally resemble the adults and wings that develop externally as wing pads
(B) The presence of a distinct pupal stage and larvae that differ radically from adults
(C) An entirely aquatic immature stage across all representative orders
(D) Mouthparts that are radically remodeled during a specialized resting stage

2016

45. Determine the correct hierarchical order of classification for a common insect, starting from the most inclusive (broadest) to the least inclusive taxon:
I. Subclass Pterygota
II. Phylum Arthropoda
III. Subphylum Mandibulata
IV. Division Neoptera
(A) II, I, III, IV
(B) II, III, I, IV
(C) III, II, IV, I
(D) II, IV, III, I

2004

46. Which order of Exopterygota is characterized by heavily sclerotized forewings called tegmina, saltatorial hind legs, and chewing mouthparts?
(A) Isoptera
(B) Thysanoptera

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(C) Orthoptera
(D) Hemiptera

2015

47. An insect with asymmetrical mouthparts (lacking the right mandible) causes rasping-sucking damage on crop leaves. Which exopterygote order does this insect belong to?
(A) Hemiptera
(B) Orthoptera
(C) Psocoptera
(D) Thysanoptera

2008

48. Identify the INCORRECT statement regarding the major exopterygote order to its typical habit or habitat.
(A) Isoptera - Eusocial colonies primarily processing cellulose
(B) Ephemeroptera - Aquatic naiads with lateral abdominal gills
(C) Odonata - Terrestrial nymphs feeding exclusively on plant roots
(D) Hemiptera - Diverse habitats, utilizing piercing-sucking mouthparts for plant sap or predation

2006

49. Which characteristic is a diagnostic feature of the Order Hemiptera?
(A) The development of true halteres on the metathorax
(B) A filter chamber in the digestive tract of phytophagous species.
(C) Chewing mouthparts adapted specifically for pollen consumption
(D) The complete absence of compound eyes in the adult stage

2021

50. Match the Endopterygote order in List I with its unique distinguishing morphological feature in List II:
List I: Order
P. Coleoptera
Q. Lepidoptera
R. Diptera
S. Hymenoptera
List II: Feature
1. Hindwings reduced to halteres
2. Forewings modified into hardened elytra
3. Wings covered with overlapping broad scales
4. Wings coupled by hamuli
(A) P-2, Q-3, R-1, S-4
(B) P-3, Q-2, R-4, S-1
(C) P-2, Q-1, R-3, S-4
(D) P-1, Q-4, R-2, S-3

2013

51. What is the fundamental role of imaginal discs in the life cycle of Endopterygote insects?
(A) Larval cell clusters that form adult structures during metamorphosis.
(B) They are specialized excretory organs active only during the pupal stage.
(C) They are sensory structures on the larval antennae used to detect pupation sites.
(D) They are defensive glands that produce repellant chemicals immediately following eclosion.

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2019

52. Identify the correct statement concerning the Order Hymenoptera.
(A) All species are highly eusocial and form complex perennial colonies.
(B) Their larvae are invariably aquatic and equipped with tracheal gills.
(C) Many species exhibit haplo-diploidy, where males develop from unfertilized eggs.
(D) They possess piercing-sucking mouthparts exclusively adapted for blood-feeding.

2003

53. Which of the following is NOT a characteristic of the Order Lepidoptera?
(A) Development proceeding via hemimetabolous metamorphosis
(B) A coiled proboscis formed by the galeae of the maxillae in adults
(C) Eruciform larvae commonly possessing abdominal prolegs equipped with crochets
(D) A pupal stage often enclosed in a silken cocoon or forming a naked chrysalis

2021

54. A larva has a well-developed head capsule, three pairs of thoracic legs, and lacks abdominal prolegs. The adult reared from it has hardened forewings meeting in a straight line down its back. To which order does it belong?
(A) Lepidoptera
(B) Diptera
(C) Hymenoptera
(D) Coleoptera

2009

55. What evolutionary consequence is most directly attributed to the holometabolous development seen in endopterygote orders?
(A) It eliminated the need for chemical

communication between sexes.
(B) It allowed life stages to use different niches, reducing competition.
(C) It severely restricted their geographical distribution to tropical zones.
(D) It resulted in a secondary loss of flight capabilities across the majority of holometabolous taxa.

2010

56. Which family within the Order Lepidoptera contains significant agricultural pests whose larvae are typically root, stem, or pod borers, and whose adults possess a distinctive tympanal organ on the metathorax?
(A) Crambidae
(B) Gelechiidae
(C) Noctuidae
(D) Papilionidae

2022

57. Identify the INCORRECT statement regarding families in the Order Lepidoptera.
(A) Gelechiidae includes the pink bollworm, a major pest of cotton.
(B) Crambidae contains numerous species of stem borers that cause severe damage to cereal crops.
(C) Noctuidae is one of the largest families, containing cutworms and armyworms.
(D) Pyralidae adults typically rest with their wings held vertically over their back, resembling a sail.

2010

58. Which morphological feature best distinguishes the family Curculionidae (weevils) from other major coleopteran families?
(A) The anterior elongation of the head into a pronounced rostrum or snout
(B) The presence of enlarged, saltatorial hind femora
(C) Elytra that are significantly shortened, exposing most of the abdominal segments
(D) Lamellicorn antennae ending in a series of movable, leaf-like plates

2003

59. Identify the INCORRECT pair associating a Coleoptera family with its characteristic features.
(A) Chrysomelidae - Phytophagous with filiform or serrate antennae
(B) Coccinellidae - Predatory with a pseudotrimerous (4-4-4) tarsal formula
(C) Scarabaeidae - Lamellicorn antennae and C-shaped larvae
(D) Curculionidae - Predatory adults with filiform antennae and aquatic larvae

2021

60. How do members of the family Pentatomidae within the Order Hemiptera generally affect agricultural systems?
(A) They cause tissue necrosis and fruit drop via piercing-sucking feeding.
(B) They act exclusively as obligate pollinators for solanaceous crops.
(C) They tunnel extensively into the xylem of trees, weakening structural integrity.
(D) They graze heavily on foliage using strong mandibles, leading to total defoliation.

2007

61. Which structural character is uniquely diagnostic for the family Cicadellidae (leafhoppers)?
(A) One or more rows of small spines running along the length of the hind tibiae
(B) Pronotum extended backward over the abdomen, often adopting bizarre shapes
(C) A pair of conspicuous cornicles located near the posterior end of the abdomen
(D) White, waxy powder covering the wings and body of the adult stage

2009

62. Which family in the Order Hemiptera is notorious for having a quiescent, "pupa-like" final nymphal instar, despite being an exopterygote, and is a major vector of plant begomoviruses?
(A) Aphididae
(B) Pentatomidae
(C) Aleyrodidae
(D) Cicadellidae

2002

63. Rapid wilting and honeydew accumulation on crop leaves, followed by the growth of sooty mold, is most likely caused by which family of insects?
(A) Scarabaeidae
(B) Gelechiidae
(C) Trichogrammatidae
(D) Aphididae

2009

64. What is the primary ecological role of the family Trichogrammatidae in agricultural ecosystems?
(A) They are aggressive predators of adult moths and butterflies during the crop season.
(B) They are important primary pollinators of leguminous crops in diverse agricultural

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settings.
(C) Microscopic egg endoparasitoids used in biological control.
(D) They are primary vectors for a variety of soil-borne fungal plant pathogens and diseases.

2024

65. Consider the following statements regarding the differences between Crustacea, Chilopoda, and Diplopoda:
I. Crustaceans characteristically possess two pairs of antennae.
II. Chilopods possess modified first trunk appendages called venom claws.
III. Diplopods have a body with one pair of legs per segment.
Which of the above statements are correct?
(A) Only I
(B) I and II
(C) II and III
(D) I, II and III

2017

66. Which structural feature best differentiates the family Braconidae from the closely related Ichneumonidae within the Order Hymenoptera?
(A) Braconids possess a highly developed stinger used exclusively for defense.
(B) Braconids have a uniquely narrow "wasp waist" (petiole), which Ichneumonids lack entirely.
(C) Braconids possess geniculate antennae with exactly 12 segments.
(D) Braconids lack a costal cell and have only one recurrent vein in the forewing.

2024

67. Which of the following dipteran families is highly valued in integrated pest management because its adults are significant pollinators while its larvae are voracious predators of aphids?
(A) Syrphidae
(B) Culicidae
(C) Tephritidae
(D) Tachinidae

2019

68. The specialized structure known as the corbicula (pollen basket) is anatomically located on which part of members of the family Apidae?
(A) The modified mandibles of the head
(B) The ventral surface of the abdominal segments
(C) The outer surface of the hind tibiae
(D) The anterior margin of the forewings

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2010

69. Which concept forms the core foundational principle of DNA barcoding in insect taxonomy?
(A) Standardized genomic sequencing to identify species accurately.
(B) Utilizing the entire nuclear genome to completely replace traditional morphological keys.
(C) Sequencing only ribosomal RNA genes to classify exclusively cryptic species.
(D) Mapping the geographical distribution of a species using epigenetic markers.

2022

70. Read the following statements and choose the correct option:
Assertion (A): The mitochondrial cytochrome c oxidase subunit I (COI) gene is the standard marker for animal DNA barcoding.
Reason (R): The COI gene exhibits a very low rate of sequence evolution, making it identical across different insect orders.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2002

71. Identify the INCORRECT statement concerning the utility of the mitochondrial COI gene in insect DNA barcoding.
(A) Mitochondrial DNA lacks introns, simplifying the amplification process.
(B) Mitochondrial DNA typically undergoes rapid recombination during meiosis, preventing lineage tracking.
(C) It generally exhibits high interspecific variation relative to low intraspecific variation.
(D) There are a high number of mitochondrial copies per cell, ensuring easy DNA extraction even from small specimens.

2001

72. In the context of phylogenetic analysis, what is a synapomorphy?
(A) A primitive character state retained from a distant ancestor
(B) A character state unique to a single terminal taxon (autapomorphy)
(C) A derived character state shared by two or more taxa and their most recent common ancestor

(D) A trait that evolved independently in two unrelated lineages due to convergent evolution

2001

73. If a taxonomic group includes a common ancestor and all of its descendants, this group is strictly defined as:
(A) Paraphyletic
(B) Polyphyletic
(C) Homoplastic
(D) Monophyletic

2019

74. Which of the following is considered a paraphyletic group in traditional insect taxonomy, based on modern cladistic analysis?
(A) Apterygota, as it excludes winged descendants of its lineage.
(B) Hexapoda, because it completely excludes the Crustacea.
(C) Neoptera, because it encompasses both Exopterygote and Endopterygote lineages.
(D) Coleoptera, due to its massive species diversity and global distribution.

2023

75. Consider the following statements regarding the features of entognathous orders:
I. Collembolans rely entirely on their wings for dispersal across habitats.
II. Diplurans generally lack eyes and possess a pair of abdominal cerci.
III. Proturans lack true antennae and utilize their modified front legs for sensory functions.
IV. Entognathous insects undergo complete, holometabolous metamorphosis.
Which of the above statements are correct?
(A) I and II
(B) I and IV
(C) III and IV
(D) II and III

2017

76. In cladistics, why are symplesiomorphies generally unhelpful for determining the evolutionary relationships and branching order within a specific clade?
(A) They are primitive traits that do not provide evidence of recent common ancestry.
(B) They are inherently prone to rapid mutation and epigenetic silencing in most eukaryotic taxa.
(C) They are purely hypothetical constructs not found in the fossil record of early insect clades.
(D) They exclusively reflect convergent evolution rather than true genetic homology within the group.

2019

77. Which pioneer conceptually formalized the principles of cladistics and phylogenetic systematics in the 20th century?
(A) Willi Hennig
(B) Charles Darwin
(C) Carolus Linnaeus
(D) Johan Christian Fabricius

2019

78. When constructing a phylogenetic tree using the Maximum Parsimony criterion, which tree is preferred?
(A) The tree that most closely aligns with the classical Linnaean taxonomic hierarchy
(B) The tree that calculates the highest probability of the observed data given a specific model of sequence evolution
(C) The tree that requires the fewest total number of evolutionary changes (steps) to explain the observed character states
(D) The tree that exclusively utilizes morphological data over molecular sequences

2024

79. Identify the INCORRECT statement regarding the computational tools and methodologies for phylogenetic trees.
(A) Bootstrapping is a statistical method used to estimate the reliability or confidence level of specific clades within a phylogenetic tree.
(B) Maximum Likelihood analysis incorporates explicit statistical models of nucleotide or amino acid substitution.
(C) Distance-matrix methods, such as Neighbor-Joining, calculate evolutionary distances to construct trees rapidly.
(D) An outgroup is deliberately chosen from within the primary study group (ingroup) to calculate the rate of internal divergence.

2014

80. Match the Entognatha/Ectognatha diagnostic characters in List I with the specific biological features in List II:
List I: Character
P. Retinaculum
Q. Johnston's organ
R. Gnathal pouch
S. Anamorphosis

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List II: Biological Feature
1. Presence in the pedicel of true insects
2. Enclosure of mouthparts
3. Abdominal segment addition during molts
4. Catch mechanism for the collembolan furcula

(A) P-2, Q-3, R-4, S-1
(B) P-4, Q-2, R-1, S-3
(C) P-1, Q-4, R-2, S-3
(D) P-4, Q-1, R-2, S-3

2017

81. Which statistical framework utilized in modern molecular systematics estimates the posterior probability of a phylogenetic tree using Markov chain Monte Carlo (MCMC) algorithms?
(A) Maximum Parsimony
(B) Bayesian Inference
(C) UPGMA
(D) Neighbor-Joining

2013

82. Which exception correctly completes the statement: All of the following constitute evidence of homoplasy, EXCEPT:
(A) Convergent evolution of similar wing structures in unrelated lineages
(B) Evolutionary reversal where a derived trait reverts to an ancestral state
(C) Parallel evolution of identical defensive chemicals in physically separated populations
(D) Homologous structures inherited directly from a recent shared common ancestor

2005

83. Why is the precise selection of an outgroup critical when utilizing computational tools to interpret a cladogram?
(A) It roots the tree, allowing for the determination of the direction of evolutionary change.
(B) It dictates the absolute geological age of every node in the tree.
(C) It ensures the final tree structure is perfectly symmetrical.
(D) It automatically converts morphological data into standard molecular barcodes.

2019

84. Which statement accurately represents the primary advantage of Bayesian inference over Maximum Parsimony in molecular insect systematics?
(A) Bayesian inference requires zero computational power and can be done manually.
(B) Bayesian inference relies solely on morphological traits, ignoring complex DNA sequences.
(C) It manages complex models and provides clade support via posterior probabilities.
(D) Bayesian inference assumes that evolutionary rates are identical across all lineages without exception.

2015

85. Consider the following statements regarding the biology of the Subclass Apterygota:
I. They exhibit ametabolous development.
II. They continue to molt even after reaching sexual maturity.
III. They utilize indirect sperm transfer via spermatophores.
IV. They possess hardened elytra that permanently cover their abdomen.
Which of the above statements are correct?
(A) I, II and III
(B) I and II only
(C) II and III only
(D) I and IV

2015

86. Based on the rules of ICZN, what is the consequence if the name designated for a new genus is identical to a generic name already established in zoology?
(A) Both names are maintained, provided they belong to different orders.
(B) The older name is suppressed to avoid confusion.
(C) A committee automatically merges the two genera into a single polyphyletic group.
(D) The junior homonym is invalid and must be replaced by a new substitute name.

2021

87. In evolutionary biology, the morphological similarities between the raptorial forelegs of a praying mantis (Dictyoptera) and those of a mantidfly (Neuroptera) are a classic example of:
(A) Synapomorphy
(B) Convergent evolution
(C) Symplesiomorphy
(D) Coevolution

2008

88. How did the shift from direct flight muscle articulation to indirect flight muscle mechanics evolutionarily advantage the higher insect orders?
(A) It completely eliminated the need for a

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tracheal system in the thoracic cavity.
(B) It facilitated the independent rotation of all four wings in opposite directions.
(C) It utilized the thoracic exoskeleton's elasticity for higher wing-beat frequencies.
(D) It forced the permanent fusion of the forewings and hindwings.

2024

89. Identify the INCORRECT statement regarding the taxonomy of hexapods.
(A) Protura is characterized by the absence of antennae and the presence of anamorphosis.
(B) Collembola typically possess a ventral tube known as the collophore.
(C) Zygentoma are ametabolous insects covered in silvery scales.
(D) Diplura possess well-developed compound eyes and three long caudal filaments.

2017

90. Which structural modification of the wings distinguishes the order Thysanoptera?
(A) Both pairs of wings are narrow, strap-like, and fringed with long marginal hairs.
(B) The forewings are heavily sclerotized tegmina, while the hindwings are reduced.
(C) The hindwings are modified into club-like halteres.
(D) Both pairs of wings are broad, identical in size, and covered with overlapping scales.

2017

91. Which feature is NOT diagnostically characteristic of the family Scarabaeidae?
(A) Lamellicorn antennae with expandable distal plates
(B) Tarsi possessing an apparent 4-4-4 segmentation formula
(C) Larvae generally adopting a C-shaped 'white grub' form
(D) Pronounced sexual dimorphism often present, including prominent horns in males

2002

92. Identify the correct pair associating a phylogenetic term with its precise definition.
(A) Polyphyly - A group containing an ancestor and all its descendants
(B) Autapomorphy - A derived trait unique to a single taxon
(C) Homology - Similarity arising solely from convergent adaptation to a shared environment
(D) Cladogram - A tree diagram where branch lengths strictly represent exact chronological time

2009

93. What environmental pressure is believed to be the primary cause for the evolutionary loss of wings (apterism) in certain advanced pterygote lineages, such as fleas (Siphonaptera) and lice (Phthiraptera)?
(A) The shift to obligate ectoparasitism on vertebrate hosts.
(B) Severe global cooling during the Pleistocene epoch
(C) The necessity to dive deep into aquatic habitats
(D) A dietary transition from carnivory strictly to xylophagy (wood-eating)

2013

94. Which of the following best defines the concept of 'homonymy' in zoological nomenclature under the ICZN?
(A) The use of multiple different names for a single species
(B) The required agreement in gender between a generic name and a specific epithet
(C) The assignment of the identical name to two or more distinct taxa
(D) The preservation of the original author's name in parentheses

2014

95. When comparing the immature stages of Ephemeroptera to those of Odonata, which functional morphological feature is distinctively unique to odonate naiads?
(A) Lateral abdominal tracheal gills
(B) The presence of developing external wing pads
(C) Ametabolous growth requiring over forty molts
(D) A modified, extensible labium used for capturing prey.

2003

96. Identify the INCORRECT statement regarding wing coupling mechanisms in Endopterygota.
(A) In many Lepidoptera, the frenulum and retinaculum system links the forewing and hindwing during flight.
(B) Hymenopterans utilize tiny hooks called hamuli on the anterior margin of the hindwing to clasp the forewing.
(C) Dipterans utilize a specialized jugal lobe to physically lock their functional forewings to

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their halteres.
(D) Wing coupling ensures the fore and hind wings function as a single aerodynamic surface, increasing flight efficiency.

2005

97. Identify the correct pair regarding the division of Subclass Pterygota based on metamorphosis.
(A) Holometabola - Paleoptera
(B) Hemimetabola - Exopterygota
(C) Ametabola - Endopterygota
(D) Paurometabola - Entognatha

2021

98. How does an understanding of a pest insect's holometabolous development critically impact agricultural pest management?
(A) It guarantees that chemical sprays applied to adults will simultaneously eradicate all larvae and eggs.
(B) It indicates that the pest will continuously damage the same crop part throughout its entire lifespan.
(C) It assures that biological control agents only need to target the egg stage for complete management.
(D) It allows targeting specific stages as larvae and adults use different niches.

2007

99. Which of the following orders is an exception, NOT belonging to the Exopterygota?
(A) Neuroptera
(B) Phthiraptera
(C) Blattodea
(D) Dermaptera

2011

100. Read the following statements and choose the correct option:
Assertion (A): Endopterygote insects constitute the vast majority of global insect diversity and agricultural pests.
Reason (R): Complete metamorphosis allows the larval and adult stages to specialize independently in feeding and reproduction, reducing intraspecific competition.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2013

101. Which fact accurately describes the caste system of the Order Isoptera (termites)?
(A) The worker and soldier castes consist exclusively of sterile individuals of both sexes.
(B) The queen reproduces via obligate parthenogenesis without male contribution.
(C) The soldiers are primarily winged to facilitate rapid colony defense.
(D) The entire colony dies annually, leaving only a few fertilized queens to overwinter.

2002

102. Which specific anatomical feature unequivocally identifies a specimen as belonging to the family Aphididae?
(A) A heavily sclerotized scutellum covering the entire abdomen
(B) Asymmetrical rasping mouthparts
(C) Thickened, raptorial forelegs adapted for grasping prey
(D) A pair of cornicles located on the dorsal posterior abdomen.

2004

103. Identify the INCORRECT statement regarding the major exopterygote order to its typical structure.
(A) Halteres - Diptera
(B) Elytra - Orthoptera
(C) Hamuli - Hymenoptera
(D) Furcula - Collembola

2006

104. What is the fundamental physiological function of the filter chamber present in the digestive tract of many Hemiptera?
(A) To physically grind hard seed coats prior to midgut absorption
(B) To filter out toxic secondary plant metabolites before they enter the hemolymph
(C) To bypass excess water and sugar, concentrating nutrients.
(D) To act as an internal lung for extracting dissolved oxygen from plant sap

2001

105. When classifying the suborders of Hemiptera, what is a primary morphological distinction of Heteroptera?
(A) Heteropterans possess uniform membranous forewings, whereas Homopterans have distinct hemelytra.
(B) Heteropterans lack functional hindwings entirely, whereas Homopterans possess four

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functional wings.
(C) Heteropterans utilize chewing mouthparts, while Homopterans use specialized piercing-sucking mouthparts.
(D) Hemelytra forewings and a beak arising from the head's anterior.

2011

106. Identify the correct statement regarding the order Phthiraptera.
(A) Obligate apterous ectoparasites with specialized tarsal claws.
(B) They are free-living predators of smaller arthropods in soil leaf litter.
(C) They possess fully functional wings that they shed immediately upon finding a host.
(D) They exhibit a holometabolous life cycle with a hardened puparium.

2019

107. Certain members of the order Thysanoptera are highly problematic because they act as the primary vectors for which type of plant pathogen?
(A) Begomoviruses
(B) Tospoviruses
(C) Phytoplasmas
(D) Powdery mildew fungi

2016

108. The modification of hindwings into small, knob-like structures called halteres is a definitive synapomorphy of which order?
(A) Diptera
(B) Hymenoptera
(C) Strepsiptera
(D) Lepidoptera

2001

109. Identify the correct pair associating an endopterygote order with its typical larval form.
(A) Lepidoptera - Eruciform
(B) Coleoptera - Exclusively aquatic naiads
(C) Hymenoptera (Apocrita) - Campodeiform, highly mobile
(D) Diptera - Scarabaeiform (white grubs)

2011

110. Match the Endopterygote orders in List I with their corresponding typical characteristics or habitats in List II:
List I: Order
P. Neuroptera
Q. Siphonaptera
R. Trichoptera
S. Strepsiptera
List II: Character/Habitat
1. Laterally compressed apterous ectoparasites
2. Larvae construct protective aquatic cases
3. Males winged, females often endoparasitic and wingless
4. Extensive wing venation, highly predatory larvae
(A) P-1, Q-2, R-3, S-4
(B) P-4, Q-1, R-2, S-3
(C) P-3, Q-4, R-1, S-2
(D) P-2, Q-3, R-4, S-1

2006

111. Which exception correctly identifies a feature NOT typically associated with the order Hymenoptera?
(A) Mandibulate mouthparts, often modified for lapping or drinking nectar
(B) A prominent ovipositor, frequently modified into a sting in advanced lineages
(C) Haplo-diploid sex determination mechanism
(D) The consistent presence of heavily sclerotized elytra protecting the abdomen

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2017

112. Identify the INCORRECT statement regarding the mouthparts of the Order Lepidoptera.
(A) Adult mouthparts are typically modified into a long, coiled siphoning tube.
(B) The proboscis is formed primarily by the greatly elongated galeae of the maxillae.
(C) In all adult Lepidoptera, functional mandibles are completely absent without exception.
(D) Lepidopteran larvae possess robust chewing mandibles necessary for consuming plant tissue.

2022

113. An insect has four large, similarly sized membranous wings containing a dense, complex network of veins. The larva is a terrestrial predator with elongated, sickle-shaped jaws. What is the most likely order?
(A) Odonata
(B) Neuroptera
(C) Mecoptera
(D) Megaloptera

2009

114. How did the haplo-diploid sex determination system in Hymenoptera likely contribute to the evolution of eusociality in this order?
(A) It ensured that all male offspring are clones of the queen, facilitating perfect male

coordination.
(B) It physically prevented worker females from ever developing ovaries.
(C) It triggered the development of a highly modified caste of sterile soldiers exclusively via epigenetic temperature shifts.
(D) High genetic relatedness among sisters favors cooperative care.

2016

115. Select the correct evolutionary sequence of wing articulation structures from basal to advanced, reflecting the transition from Paleoptera to Neoptera:
(A) Complete loss of axillary sclerites → Fusion of wing base → Direct muscle attachment
(B) Third axillary sclerite → Indirect flight muscles → Prominent jugal lobe
(C) Direct flight muscle attachment → Development of the third axillary sclerite → Refined indirect flight muscle utilization
(D) Indirect flight muscle utilization → Direct flight muscle attachment → Complete loss of axillary sclerites

2017

116. In which family of Lepidoptera do adults commonly possess tympanal organs on the metathorax, aiding them in detecting the echolocation calls of predatory bats?
(A) Papilionidae
(B) Bombycidae
(C) Noctuidae
(D) Pieridae

2011

117. Which anatomical feature is primarily used by taxonomists to differentiate the family Crambidae from the closely related Pyralidae?
(A) Crambids possess a specific tympanal organ structure known as the praecinctorium, which Pyralids lack.
(B) Crambids completely lack a proboscis, whereas Pyralids have a highly extended one.
(C) Crambids possess functional halteres on the metathorax.
(D) Pyralids possess prominent, feathery antennae, while Crambids possess strictly filiform antennae.

2002

118. Identify the correct statement characterizing the family Gelechiidae.
(A) It exclusively comprises large, diurnal butterflies known for extensive migrations.
(B) Its larvae are entirely aquatic and construct cases out of sand and pebbles.
(C) Adults exhibit heavily fringed wings and lack functional mouthparts, dying within hours of emergence.
(D) Small moths including pests like pink bollworm and potato tuber moth.

2001

119. Identify the INCORRECT pair linking a lepidopteran family to one of its major agricultural pest representatives.
(A) Noctuidae - Spodoptera frugiperda (Fall armyworm)
(B) Gelechiidae - Helicoverpa armigera (Cotton bollworm)
(C) Crambidae - Chilo partellus (Spotted stem borer)
(D) Pyralidae - Corcyra cephalonica (Rice moth)

2019

120. Which feature is NOT considered characteristic of the lepidopteran family Pyralidae?
(A) The presence of a scaled proboscis at the base
(B) Tympanal organs located at the base of the abdomen
(C) Hindwings strictly possessing a jugum for wing coupling with the forewing
(D) Small to medium-sized adults, often resting with wings folded flat or tent-like over the body

2024

121. What is the primary function of the prolonged rostrum (snout) found in members of the family Curculionidae?
(A) It functions as an elongated siphoning tube for extracting deep floral nectar.
(B) It acts as a specialized auditory organ to detect vibrations from potential mates within wood.
(C) It is a purely ornamental structure used exclusively in male-male territorial combat.
(D) It houses the chewing mouthparts at its tip, facilitating feeding on internal plant tissues and excavating oviposition sites.

2005

122. Identify the INCORRECT statement regarding the family Coccinellidae.
(A) All species within the family are strictly carnivorous, making them universally beneficial in agriculture.

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(B) Most species are highly beneficial predators of aphids and scale insects during both larval and adult stages.
(C) They typically possess a highly convex, oval body shape, often brightly colored with contrasting spots.
(D) Members of the subfamily Epilachninae are phytophagous and can be serious pests of cucurbits and solanaceous crops.

2004

123. Identify the correct pair associating a coleopteran family with its defining diagnostic character.
(A) Curculionidae - Filiform antennae and predatory aquatic larvae
(B) Scarabaeidae - Robust with lamellicorn antennae and distal leaf plates
(C) Chrysomelidae - Highly elongated raptorial forelegs
(D) Coccinellidae - Long, flexible elytra that do not cover the terminal abdominal segments

2023

124. Why is the family Chrysomelidae economically significant in global agriculture?
(A) Leaf beetles whose larvae and adults are voracious defoliators.
(B) Its members are the primary biological control agents used against invasive weed species worldwide.
(C) It exclusively contains species that act as vital pollinators for deeply hidden floral structures.
(D) It is the primary group of beetles responsible for transmitting deadly zoonotic diseases to livestock.

2015

125. Consider the following statements regarding the distinguishing traits of the family Curculionidae:
I. They belong to the suborder Adephaga.
II. Their antennae are characteristically geniculate (elbowed) and clubbed.
III. Their larvae are typically apodous (legless) and grub-like.
Which of the above statements are correct?
(A) II and III
(B) I and II
(C) I and III
(D) Only II

2021

126. When identifying members of the family Coccinellidae, a taxonomist observes their tarsal formula. While structurally pseudotrimerous, what is the actual biological tarsal formula of Coccinellidae?
(A) 5-5-5
(B) 4-4-4
(C) 3-3-3
(D) 2-2-2

2006

127. Identify the coleopteran family that is generally valued for its predatory biocontrol potential.
(A) Curculionidae
(B) Chrysomelidae
(C) Scarabaeidae (Melolonthinae)
(D) Coccinellidae

2005

128. What precise function do the cornicles (siphunculi) of the Aphididae serve?
(A) They are primary reproductive organs for viviparous birth.
(B) They continuously excrete honeydew to attract mutualistic ants.
(C) Exuding defensive fluids containing alarm pheromones and wax.
(D) They serve as the primary spiracles for rapid oxygen intake during flight.

2023

129. Identify the INCORRECT statement describing the developmental biology of the family Aleyrodidae (whiteflies).
(A) The first-instar nymph (crawler) is highly mobile and actively seeks a feeding site on the plant.
(B) They are holometabolous insects with pupal stages like Diptera.
(C) Subsequent nymphal instars are sessile and scale-like, remaining attached to the plant tissue.
(D) The adult stage possesses four functional wings lightly covered with a white, waxy powder.

2014

130. Read the following statements and choose the correct option:
Assertion (A): Heavy infestations of certain Cicadellidae (leafhoppers) cause a distinct phytotoxic symptom known as 'hopperburn'.
Reason (R): The mechanical disruption of the phloem coupled with the injection of toxic salivary enzymes during feeding disrupts plant physiology, leading to necrosis.
(A) Both A and R are true and R is the correct explanation of A.

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(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2024

131. Which anatomical feature is uniquely prominent in the family Pentatomidae, often extending posteriorly over the abdomen?
(A) A large, triangular or shield-shaped scutellum
(B) The elongated rostrum
(C) The heavily modified forelegs
(D) A pair of elongated cerci

2012

132. Identify the correct pair associating a hemipteran family with its role as a vector for pathogens.
(A) Pentatomidae - Primary vectors of citrus greening bacteria (HLB)
(B) Aphididae - Exclusive vectors of all known plant nematodes
(C) Cicadellidae - Primary vectors of Tungro viruses and various phytoplasmas
(D) Aleyrodidae - Primary vectors of the Xylella fastidiosa bacterium

2004

133. How does the concept of parthenogenesis directly impact the population dynamics and pest status of the family Aphididae?
(A) Rapid overlapping generations of clones trigger explosive outbreaks.
(B) It drastically reduces their genetic diversity, rendering them highly susceptible to all contact insecticides.
(C) It ensures that their life cycle strictly synchronizes with a single seasonal host plant per year.
(D) It completely halts their reproduction during the warm summer months, providing a natural break in pest pressure.

2017

134. Which of the following hemipteran families is a negative exception, NOT generally known for possessing a highly developed digestive filter chamber?
(A) Cicadellidae
(B) Aphididae
(C) Aleyrodidae
(D) Pentatomidae

2021

135. Consider the following statements concerning the family Trichogrammatidae:
I. They are microscopic wasps entirely parasitic on adult beetles.
II. Their tarsi typically possess only 3 segments.
III. Their forewings are often broad, fringed with hairs, and display highly reduced venation.
IV. They are exclusively phytophagous in their larval stage.
Which of the above statements are correct?
(A) I, II and IV
(B) I and III
(C) II and III
(D) II, III and IV

2006

136. Which diagnostic wing feature is typically utilized to separate the family Braconidae from the family Ichneumonidae?
(A) The presence of a prominent pterostigma in Braconidae, completely absent in Ichneumonidae
(B) The complete absence of hindwings in all adult Braconidae
(C) The lack of the 2nd recurrent vein (vein 2m-cu) in the forewing of Braconidae
(D) Braconidae having highly reduced, scale-like wings similar to a mosquito

2024

137. The presence of a "spurious vein" is a classic taxonomic character for which beneficial dipteran family?
(A) Tachinidae
(B) Asilidae
(C) Cecidomyiidae
(D) Syrphidae

2004

138. Identify the INCORRECT statement regarding the family Apidae.
(A) The specialized corbicula (pollen basket) is located on the highly modified anterior surface of the fore tibiae.
(B) It encompasses important pollinator groups including honey bees, bumblebees, and carpenter bees.
(C) Their mouthparts are fundamentally mandibulate but highly modified to form a maxillo-labial complex for lapping nectar.
(D) Many species exhibit advanced eusocial behavior, constructing elaborate wax comb structures.

2003

139. Identify the correct pair associating a beneficial insect family with its ecological function.

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(A) Trichogrammatidae - Pollination of greenhouse tomatoes
(B) Braconidae - Endoparasitoids of Lepidoptera and other orders
(C) Syrphidae - Endoparasitoids of heavily armored scale insects
(D) Apidae - Aggressive predators of adult dipterans

2023

140. Match the beneficial insect family in List I with its dominant life-stage characteristic or functional role in List II:
List I: Family
P. Trichogrammatidae
Q. Apidae
R. Syrphidae
S. Braconidae
List II: Character/Role
1. "Slug-like" larvae voraciously consuming aphids
2. Minute egg parasitoids widely mass-reared
3. Eusocial or solitary obligate foragers of pollen/nectar
4. Frequently spin prominent silken cocoons on or near host larvae
(A) P-2, Q-4, R-1, S-3
(B) P-4, Q-3, R-2, S-1
(C) P-3, Q-2, R-4, S-1
(D) P-2, Q-3, R-1, S-4

2004

141. How are the larvae of the family Syrphidae utilized strategically in biological control programs?
(A) As highly effective, mobile predators deployed to quickly reduce dense aphid populations on crops.
(B) As obligate hyperparasitoids to control populations of harmful braconid wasps.
(C) As soil-dwelling nematodes that actively hunt root-feeding grubs.
(D) As the primary biological vectors of beneficial entomopathogenic fungi to whiteflies.

2019

142. What is the operational definition of "DNA barcoding" in the context of modern insect taxonomy?
(A) The whole-genome sequencing of an organism to map every phenotypic trait back to its genetic origin.
(B) The strictly quantitative measurement of total DNA content to distinguish between closely related taxa.
(C) The use of a standardized, short genomic sequence to identify specimens accurately and assign them to known or novel species.
(D) The process of modifying an insect's DNA using CRISPR to induce a visible, fluorescent barcode on its cuticle.

2006

143. Why is the mitochondrial cytochrome c oxidase subunit I (COI) gene explicitly chosen as the universal marker for animal DNA barcoding?
(A) It is the longest gene in the entire mitochondrial genome, providing maximum data.
(B) It undergoes rapid recombination, allowing taxonomists to easily track maternal and paternal lineages simultaneously.
(C) It is completely immune to any form of evolutionary mutation, acting as an unchanging molecular clock.
(D) It has favorable divergence rates between species and low variation within.

2013

144. Identify the INCORRECT statement regarding the biological properties of mitochondrial DNA (mtDNA) that favor its use in molecular systematics.
(A) mtDNA is generally inherited maternally, effectively removing the complexities of genetic recombination.
(B) mtDNA lacks introns, making the target sequences easier to align and analyze computationally.
(C) The mutation rate of mtDNA is significantly slower than that of most nuclear genes, making it useless for recently diverged species.
(D) The high copy number of mtDNA per cell facilitates efficient DNA extraction and PCR amplification.

2012

145. Consider the following statements concerning the standard protocols and markers for DNA barcoding:
I. The standard barcode region for insects is an approximately 658 base-pair segment of the COI gene.
II. Total genomic DNA must be completely destroyed prior to isolating the mitochondrial fraction.
III. PCR (Polymerase Chain Reaction) is utilized to selectively amplify the target COI region.
IV. Sanger sequencing is the traditional method

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used to read the amplified barcode sequence.
V. The obtained sequence is typically compared against a global reference database like BOLD.

Which of the above statements are correct?
(A) I, III, IV and V
(B) II, III, IV and V
(C) I, II and III
(D) I, IV and V

2010

146. What is the direct analytical effect of the lack of introns in the mitochondrial COI gene during sequence alignment?
(A) It forces the sequence to continuously flip between forward and reverse reading frames.
(B) It makes PCR amplification impossible without specialized restriction enzymes.
(C) It ensures that the gene codes for structural RNA rather than functional proteins.
(D) It simplifies alignment as there are rarely indels causing frame shifts.

2005

147. A taxonomist is studying two populations of morphologically identical pests that exhibit different resistance profiles to insecticides. How is DNA barcoding conceptually applied to resolve this issue?
(A) Sequencing COI regions to identify deep genetic divergence in cryptic species.
(B) By completely replacing traditional morphological classification with purely geographic distribution data.
(C) By actively mutating the COI gene to observe if resistance is lost in the subsequent generation.
(D) By using the COI gene to directly manufacture targeted, species-specific chemical pesticides.

2021

148. In cladistic methodology, what specific term defines a derived character state that is shared by two or more taxa and is presumed to have been present in their most recent common ancestor?
(A) Autapomorphy
(B) Symplesiomorphy
(C) Synapomorphy
(D) Homoplasy

2009

149. Which defining parameter strictly differentiates a monophyletic group from a paraphyletic group?
(A) Monophyly includes an ancestor and all descendants; paraphyly excludes some.
(B) A monophyletic group is based on morphological data, while a paraphyletic group is based on molecular data.
(C) A monophyletic group represents an unnatural grouping caused by convergent evolution, unlike a paraphyletic group.
(D) A monophyletic group is composed of taxa from multiple disparate evolutionary lineages.

2009

150. Identify the INCORRECT statement regarding foundational concepts in phylogenetic analysis.
(A) Cladistics fundamentally groups organisms based strictly on shared derived characteristics rather than overall similarity.
(B) The principle of parsimony favors the evolutionary hypothesis that requires the fewest evolutionary changes.
(C) An autapomorphy is uniquely derived in a single terminal lineage and cannot be used to establish relationships with other taxa.
(D) Symplesiomorphies provide strong evidence for monophyletic clades.

2024

151. Identify the correct pair associating a phylogenetic term with its scientific originator or definition.
(A) Maximum Likelihood - Carolus Linnaeus
(B) Phylogenetic Systematics (Cladistics) - Willi Hennig
(C) Biological Species Concept - Willi Hennig
(D) Principle of Priority - Charles Darwin

2019

152. Which term indicates an artificial taxonomic group consisting of taxa derived from multiple, independent ancestors, thereby excluding the most recent common ancestor of all members?
(A) Monophyletic
(B) Paraphyletic
(C) Polyphyletic
(D) Holophyletic

2015

153. What logical inference can be drawn if phylogenetic analysis reveals that highly similar traits evolved independently in two distinct, unrelated insect orders?
(A) The traits are synapomorphies confirming a recent shared common ancestor.
(B) The entire cladogram must be strictly inverted to reflect true morphological relationships.

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(C) The classical Linnaean taxonomic hierarchy is mathematically infallible.
(D) Traits represent homoplasy from convergent evolution via ecological pressure.

2022

154. Which definition accurately describes the "Maximum Parsimony" optimality criterion used in the computational construction of phylogenetic trees?
(A) Selecting the tree that minimizes the total number of character-state changes required to explain the observed data.
(B) Selecting the tree that calculates the highest statistical probability under a specific model of DNA mutation.
(C) Selecting the tree based solely on the shortest overall geographic distance between sampled populations.
(D) Selecting the tree that strictly aligns with historical morphological classifications.

2017

155. Arrange the following computational steps in the correct standard sequence for constructing a molecular phylogenetic tree:
I. Calculation of tree topology using an optimality criterion
II. DNA extraction and targeted sequencing
III. Multiple sequence alignment of the molecular data
IV. Statistical evaluation of nodal support
(A) III, II, I, IV
(B) II, I, III, IV
(C) II, III, I, IV
(D) III, I, II, IV

2021

156. In the computational evaluation of phylogenetic trees, what is the specific purpose of "bootstrapping"?
(A) To physically extract DNA from highly degraded museum specimens.
(B) Statistically resampling datasets to estimate confidence in specific branches.
(C) To mathematically force a polyphyletic group into a monophyletic clade.
(D) To strictly determine the absolute geological time of divergence between two nodes.

2009

157. Identify the correct statement regarding Maximum Likelihood (ML) models in insect systematics.
(A) ML finds the most probable tree using mathematical models of substitution.
(B) ML is the oldest method of classification, relying entirely on visual comparison.
(C) ML systematically completely ignores homoplasy.
(D) ML trees can never be rooted, representing only relative relationships.

2008

158. When a computational tool generates an unrooted cladogram, what application is immediately required to determine the direction of evolutionary change?
(A) The exclusion of all parsimony-informative characters from the dataset
(B) The automatic conversion of all molecular data back into structural morphology
(C) Using an appropriate outgroup, a taxon closely related to but outside the ingroup.
(D) The immediate elevation of all subspecies to full specific status

2011

159. Which of the following is NOT categorized as an optimality criterion utilized by computational tools for choosing the best phylogenetic tree?
(A) Maximum Parsimony
(B) Maximum Likelihood
(C) Bayesian Inference
(D) Bootstrapping Resampling

2017

160. Which part of the insect brain is primarily responsible for processing visual information received from the compound eyes?
(A) Protocerebrum
(B) Deutocerebrum
(C) Tritocerebrum
(D) Subesophageal ganglion

****

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ANSWERS

1. (B) Aristotle
Aristotle was a foundational figure in entomological history who utilized wing characteristics to categorize various insect groups. He introduced the division of insects into the Pterota, which included those possessing wings, and the Aptera, comprising wingless forms. This early morphological approach provided a structured basis for understanding the diversity of the insect world during classical antiquity and early science.

2. (D) Johan Christian Fabricius based his primary classification of insects on the structural variation of their wings.
Johan Christian Fabricius, a student of Linnaeus, was a prolific entomologist who revolutionized insect taxonomy through his extensive works. However, his primary method of classification was not based on wing structure. Instead, he emphasized the morphology of mouthparts as the most reliable diagnostic feature for distinguishing orders. This focus on feeding apparatus significantly contrasted with systems based on wings.

3. (A) Linnaeus's Systema Naturae, 10th Edition (1758)
The tenth edition of Carolus Linnaeus's Systema Naturae, published in 1758, is universally recognized as the formal beginning of modern zoological nomenclature. This monumental work consistently applied the binomial system to classify the animal kingdom, including insects. The International Code of Zoological Nomenclature officially designates this specific publication date as the starting point for determining the validity of names.

4. (C) The type and structure of insect mouthparts
Johan Christian Fabricius shifted the focus of entomological classification from wings to the detailed structure of the mouthparts. He believed that the feeding organs provided more consistent and phylogenetically significant characters for defining insect orders. This "Maxillary System" allowed for a more granular differentiation of species and influenced subsequent generations of taxonomists who studied functional morphology and evolution.

5. (B) II and III
Fabricius was a student of Linnaeus who advanced taxonomy by emphasizing the structure of maxillae and other mouthparts. Meanwhile, Aristotle made early contributions by recognizing the differences between insects with membranous wings and those with modified forewings. Linnaeus actually classified insects into seven orders, not ten, and his system was based on wing characteristics rather than habitat alone.

6. (D) It served as the central repository for collections used in systematic taxonomic studies.
The establishment of the Indian Museum in Calcutta in 1814 played a pivotal role in the development of entomology in India. It functioned as a primary center for the preservation and study of insect specimens collected from across the region. This repository facilitated systematic research and taxonomic descriptions, providing the necessary infrastructure for scientists to document the country's biodiversity.

7. (B) H.M. Lefroy
Harold Maxwell Lefroy was a distinguished entomologist who served as the first Imperial Entomologist of India at the Imperial Agricultural Research Institute. He made monumental contributions to Indian entomology, most notably by authoring the comprehensive textbook "Indian Insect Pests" in 1906. His work laid the foundation for applied entomology and pest management strategies tailored to the diverse Indian agricultural landscape.

8. (C) E.P. Stebbing - First Imperial Entomologist of India
While E.P. Stebbing was a significant figure in forest entomology and authored works on Indian forest insects, he was not the first Imperial Entomologist. That distinction belongs to H.M. Lefroy. Other pioneers correctly identified include T.B. Fletcher, known for his work on South Indian insects, and Lionel de Niceville,

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who specialized in the taxonomy and study of Indian butterfly species.

9. (D) It must be consistently applied using a trinomial format for generic designations.
The International Code of Zoological Nomenclature mandates that a scientific name for a species must follow a binomial format, consisting of a genus and a specific epithet. While trinomials are used for subspecies, they are not a requirement for standard generic or specific designations. Other rules require names to be properly published, accompanied by descriptive characters, and written in Latin.

10. (D) A is false but R is true.
The Principle of Priority states that the oldest available name is the valid name for a taxon. However, a junior synonym can replace a senior synonym under specific circumstances, such as when the senior name is suppressed by the ICZN to promote stability. Therefore, the assertion that a junior synonym can never replace a senior name is technically incorrect in taxonomy.

11. (B) Biological Species Concept
The Biological Species Concept defines a species as a group of actually or potentially interbreeding natural populations that are reproductively isolated from other such groups. Even if two populations appear morphologically identical, their inability to produce viable offspring under natural conditions justifies their classification as distinct species. This concept prioritizes genetic and reproductive boundaries over physical appearance in taxonomic decisions.

12. (A) Holotype
In zoological nomenclature, a holotype is the single physical specimen designated by the original author as the name-bearing type when a new species is described. This specimen serves as the ultimate reference point for the identity of the taxon. If the holotype is lost or destroyed, researchers may later designate other types, but the holotype remains the primary standard.

13. (A) Two different species in the same genus are mistakenly given the exact same specific epithet.
The Principle of Homonymy applies when the same name is given to two or more different taxa. In a genus, each species must have a unique specific epithet to avoid confusion. If two different species are assigned the same name, the later name is considered a junior homonym and must be replaced, ensuring that every biological entity has a distinct name.

14. (C) Insects and symphylans share a common terrestrial ancestor with similar labial structures.
The Symphylan theory of insect origins suggests that hexapods evolved from a terrestrial ancestor closely resembling modern symphylans. This theory relies on morphological homologies, particularly the structure of the head and the presence of a labium formed by the fusion of the second maxillae. It posits a shared evolutionary path for these groups within the broader context of arthropod development.

15. (A) I and III
The Pancrustacea theory is a major phylogenetic hypothesis stating that hexapods and crustaceans form a single monophyletic group. Supported by modern molecular data, it suggests that hexapods emerged as a specialized terrestrial lineage within the broader crustacean clade. This refutes older theories that grouped hexapods more closely with myriapods, fundamentally changing our understanding of the arthropod tree of life.

16. (C) The shared trait of metameric segmentation and a ventral nerve cord
The Annelid theory of arthropod origins was historically supported by striking similarities in body organization, specifically metameric segmentation and a double ventral nerve cord. These features suggested a direct evolutionary link between annelids and arthropods. However, modern molecular phylogenetics has largely refuted this connection, placing these groups in separate clades and suggesting that such structural similarities may be convergent.

17. (B) It possesses dicondylic mandibles, suggesting true insects existed by the early Devonian period.
Rhyniognatha hirsti is a critically important fossil because its mouthparts exhibit dicondylic mandibles, a trait characteristic of more advanced insects. This discovery pushes the origin of true insects back to the early Devonian period, much earlier than previously thought. The presence of such specialized features suggests that insect diversification was already well underway by this stage in Earth's geological history.

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18. (D) Beaked piercing-sucking mouthparts and prothoracic winglets.
The extinct order Palaeodictyoptera is characterized by several unique morphological features, including the presence of prothoracic winglets, which are small lobe-like structures on the first thoracic segment. Additionally, these ancient insects possessed beak-like mouthparts adapted for piercing and sucking plant tissues. They were prominent during the Carboniferous and Permian periods but vanished during the mass extinction at the end of the Paleozoic.

19. (A) It caused a bottleneck, extinguishing primitive orders like Palaeodictyoptera.
The Permian-Triassic extinction event was a major turning point in insect evolution, resulting in the disappearance of several primitive orders, including the Palaeodictyoptera. This event created a significant evolutionary bottleneck, clearing ecological niches and paving the way for the radiation of modern insect groups. While insects were resilient, the loss of these basal lineages fundamentally altered the composition of terrestrial ecosystems.

20. (C) P-4, Q-2, R-3, S-1
The Symphylan theory was championed by Imms, focusing on head structure homologies. The Pancrustacea theory is strongly supported by recent molecular evidence. The Annelid theory relies on shared segmentation and nervous system patterns. Finally, hexapod polyphyly suggests that different lineages, like Entognatha and Ectognatha, may have evolved terrestrial adaptations independently rather than sharing a single common ancestor.

21. (A) An open system where hemolymph bathes internal organs directly within the haemocoel
Members of the Phylum Arthropoda possess an open circulatory system, which is a defining physiological characteristic. In this system, the fluid, known as hemolymph, is pumped by a dorsal heart into a body cavity called the haemocoel. This allows the hemolymph to directly bathe the internal organs, facilitating the exchange of nutrients and waste products without a continuous vessel network.

22. (D) The nervous system is characterized by a dorsal brain connected to a dorsal nerve cord.
Arthropods are characterized by a chitinous exoskeleton, growth via ecdysis, and striated muscles attached to internal surfaces. However, their nervous system consists of a dorsal brain connected via circumesophageal connectives to a ventral nerve cord, not a dorsal one. This ventral arrangement of the primary nerve pathway is a fundamental anatomical feature that distinguishes arthropods and many other protostomes.

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23. (B) It allows for specialization of body regions for distinct biological functions.
Tagmosis is the evolutionary process where segments fuse or modify to form specialized functional units called tagmata, such as the head, thorax, and abdomen. This organization provides a significant advantage by allowing different body regions to become highly specialized for tasks like sensory perception, locomotion, and reproduction. This structural efficiency has contributed greatly to the immense success and diversity of arthropods.

24. (C) True mandibles adapted for biting and chewing
The subphylum Trilobitomorpha, consisting of the extinct trilobites, possessed a distinctly segmented body and biramous appendages on most segments. However, they lacked true mandibles, which are the specialized mouthparts found in the subphylum Mandibulata. Instead, trilobites often used the basal portions of their legs to process food, a condition that differentiates them from the lineages that gave rise to insects.

25. (C) II and IV
Trilobitomorpha were marine arthropods that dominated the Paleozoic era. Their bodies were divided into three longitudinal lobes: a central axial lobe and two lateral pleural lobes. While they were diverse, they were strictly marine and lacked tracheal systems. Their appendages were typically biramous, and many species possessed complex compound eyes rather than just simple ocelli, reflecting their sophisticated sensory capabilities.

26. (A) Chelicerates use pre-oral chelicerae while mandibulates use post-oral mandibles.
The primary distinction between the mouthparts of Chelicerata and Mandibulata lies in their anatomical origin and structure. Chelicerates possess pre-oral chelicerae used for grasping or piercing. In contrast, mandibulates possess post-

oral mandibles, which are specialized for biting and chewing. This fundamental difference in feeding apparatus reflects divergent evolutionary paths and ecological strategies between these two major groups of the phylum Arthropoda.

27. (B) Tetranychidae - Phytophagous sap-feeders
The family Tetranychidae, commonly known as spider mites, represents a group of agriculturally significant arachnids. These mites are obligate phytophagous pests that use specialized mouthparts to pierce plant cells and feed on the sap. Their feeding activities often lead to stippling, yellowing, and significant yield loss in various crops, making them a primary focus of integrated pest management in agriculture.

28. (A) A prosoma and opisthosoma that are not broadly fused.
In most arachnids, the body is divided into a distinct prosoma and opisthosoma. However, in the Order Acari, which includes mites and ticks, these two regions are broadly fused, often showing no visible external segmentation. While they still possess four pairs of legs as adults and lack antennae, this lack of a distinct waist or division is a key diagnostic feature.

29. (A) Mandibulates possess antennae, whereas chelicerates inherently lack them.
A fundamental sensory difference between Mandibulata and Chelicerata is the presence or absence of antennae. Mandibulates, including insects, crustaceans, and myriapods, possess at least one pair of antennae used for environmental sensing. Chelicerates, such as spiders, scorpions, and mites, lack antennae entirely. They rely instead on other structures like pedipalps or specialized sensory hairs on their legs to perceive their surroundings.

30. (C) Chilopods possess modified first trunk appendages called venom claws.
Class Chilopoda and Class Diplopoda can be clearly distinguished by several traits. Chilopods possess a single pair of legs per segment and have the first pair of trunk appendages modified into venom claws for predation. Diplopods, or millipedes, generally have two pairs of legs on most body segments due to the fusion of segments and are primarily detritivorous, lacking venom claws.

31. (D) Diplopods are universally highly venomous and pose a significant direct threat to livestock.
Diplopods are generally detritivores that play a beneficial role in breaking down organic matter in the soil. Unlike chilopods, they are not predatory and do not possess venom claws. While some may secrete defensive chemicals, they are not considered a significant direct threat to livestock. In contrast, crustaceans are major food sources, and chilopods are often beneficial predators in agricultural soils.

32. (C) A body divided into exactly three tagmata: head, thorax, and abdomen
The Class Hexapoda is strictly defined by several synapomorphies, most notably the division of the body into three distinct tagmata: the head, the thorax, and the abdomen. The thorax is further specialized into three segments, each bearing a pair of uniramous legs, totaling six legs. This structural organization distinguishes hexapods from other arthropods like crustaceans or arachnids that have different body regions.

33. (B) It consolidated locomotive appendages into three segments with uniramous legs.
The hexapod thorax is a specialized locomotor center consisting of three segments: the prothorax, mesothorax, and metathorax. Each segment bears a pair of uniramous legs, providing the characteristic six-legged gait. This consolidation allowed for efficient movement and later provided the structural foundation for the development of wings on the mesothorax and metathorax, facilitating the evolution of flight in the Pterygota.

34. (D) The enclosure of the mouthparts within a cranial gnathal pouch.
The primary morphological distinction between Entognatha and Ectognatha is the location of the mouthparts. In entognathous insects, the mouthparts are enclosed within a specialized pouch formed by the growth of the lateral cranial folds. In ectognathous insects, which include all true insects, the mouthparts are exposed and project externally from the head. This division represents a fundamental divergence in hexapod evolution.

35. (A) Biramous appendages → Entognathy → Dicondylic mandibles → Wings
The evolution of hexapods involved several major structural transitions. Basal arthropods

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possessed biramous appendages, which were later simplified to uniramous legs. The development of entognathy characterized primitive hexapod lineages. True insects then evolved dicondylic mandibles, providing greater biting strength. Finally, the emergence of wings in the Pterygota allowed for flight, representing one of the most significant events in the history of life on Earth.

36. (C) Their abdomen consists of exactly six segments and usually bears a ventral tube (collophore).
Collembola, commonly known as springtails, are hexapods characterized by a six-segmented abdomen. They typically possess a unique ventral tube called the collophore, used for osmoregulation and moisture absorption. Most species also feature a furcula for jumping and a retinaculum to hold it. They are ametabolous and wingless, living primarily in soil and leaf litter where they consume decaying organic matter and fungi.

37. (A) Protura
Protura is a unique order of entognathous hexapods that exhibits anamorphosis. This is a developmental process where additional abdominal segments are added during the molting process until the adult number of twelve is reached. Proturans are also notable for lacking antennae and eyes, instead using their front legs as sensory organs. They are typically found in moist soil and leaf litter environments.

38. (D) They possess an internal gnathal pouch enclosing their mouthparts.
The subclass Apterygota includes primitive, primarily wingless insects that undergo ametabolous development and often retain pregenital abdominal appendages. However, members of Apterygota, such as silverfish and jumping bristletails, are ectognathous, meaning their mouthparts are not enclosed in a gnathal pouch. The trait of enclosed mouthparts is strictly characteristic of the class Entognatha, which is a separate group within the hexapods.

39. (B) Archaeognatha possess monocondylic mandibles and large contiguous compound eyes.
Archaeognatha, or jumping bristletails, differ from Zygentoma, or silverfish, in several key ways. Archaeognatha possess primitive monocondylic mandibles with a single articulation point and large compound eyes that meet in the middle. Zygentoma have more advanced dicondylic mandibles and eyes that are small or absent. Additionally, Archaeognatha are capable of jumping using their tail-like filaments, a behavior not typically seen in silverfish.

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40. (A) Both A and R are true and R is the correct explanation of A.
The subclass Pterygota is considered monophyletic, suggesting that the ability to fly evolved just once in the common ancestor of all winged insects. This is supported by the fact that even secondarily wingless insects share homologous structural features, such as wing articulation points and similar tracheation patterns. These shared characters provide strong evidence for a single evolutionary origin of wings within the hexapod lineage.

41. (D) Neopterans can fold their wings flat over their abdomen at rest using specialized axillary sclerites.
The primary functional difference between Neoptera and Paleoptera is the mechanism of wing folding. Neopterans possess a specialized third axillary sclerite and associated muscles that allow them to fold their wings flat over the abdomen. Paleopterans, like dragonflies and mayflies, lack this mechanism and must hold their wings either outstretched or together vertically, a more primitive condition that limits their ability to hide.

42. (A) The order Ephemeroptera is uniquely classified as a neopteran insect with ametabolous development.
The order Ephemeroptera, or mayflies, belongs to the division Paleoptera, not Neoptera. Like other paleopterans, mayflies cannot fold their wings over their abdomen. They undergo hemimetabolous development, featuring aquatic nymphs. While the subimago stage is unique to mayflies, they are fundamentally distinct from neopteran insects, which include all orders capable of folding their wings through advanced articulation sclerites and muscular control.

43. (B) The internal versus external development of wings during the immature stages
The classification into Exopterygota and Endopterygota is based on how wings develop during the immature stages. Exopterygotes develop wings externally as visible wing pads on the thorax of nymphs. In contrast,

Endopterygotes develop wings internally within specialized structures called imaginal discs during the larval stages, with the wings becoming visible only after the pupal molt. This distinction reflects different strategies of metamorphosis.

44. (A) Nymphs that generally resemble the adults and wings that develop externally as wing pads
Exopterygota, also known as Hemimetabola, are characterized by incomplete metamorphosis. The immature stages, called nymphs, generally resemble the adults in body form and habitat. Wings develop externally as pads on the thorax and gradually increase in size with each molt. This developmental pattern lacks a pupal stage, with the final molt directly producing the sexually mature, fully winged adult insect.

45. (B) II, III, I, IV
The hierarchical classification of an insect begins with the Phylum Arthropoda, followed by the Subphylum Mandibulata. It then proceeds to the Subclass Pterygota, which includes all winged insects and their descendants. Finally, the Division Neoptera represents a more specific group of insects capable of folding their wings. This sequence moves from the broadest level of organization to increasingly specialized evolutionary lineages within the hexapods.

46. (C) Orthoptera
The order Orthoptera, which includes grasshoppers and crickets, is distinguished by several key features. They possess chewing mouthparts and front wings modified into thickened, leathery structures called tegmina. Their hind legs are typically saltatorial, being enlarged and adapted for jumping. This combination of protective forewings and specialized locomotion is characteristic of the order and serves both defensive and dispersal functions in various habitats.

47. (D) Thysanoptera
Thysanoptera, commonly known as thrips, are characterized by unique, asymmetrical mouthparts where the right mandible is reduced or absent. They use their specialized mouthparts to rasp plant surfaces and suck the exuded juices, causing characteristic damage. These insects are small, often possessing fringe-like wings, and include many important agricultural pests that can also transmit plant viruses, particularly within the Tospovirus genus.

48. (C) Odonata - Terrestrial nymphs feeding exclusively on plant roots
Odonata, which includes dragonflies and damselflies, possess aquatic immature stages known as naiads. These naiads are highly predatory and use a specialized, extensible labium to capture aquatic prey. They do not live on land or feed on plant roots. Other exopterygote orders like Isoptera are eusocial, Ephemeroptera have aquatic nymphs with gills, and Hemiptera use piercing-sucking mouthparts to feed on various fluids.

49. (B) A filter chamber in the digestive tract of phytophagous species.
A diagnostic feature of many Hemiptera, particularly those that feed on plant sap, is the presence of a filter chamber in the digestive system. This structure allows the insect to bypass excess water and sugars from the nutrient-poor sap, concentrating essential proteins and minerals for absorption. This physiological adaptation is necessary for survival on a high-volume liquid diet and results in the excretion of honeydew.

50. (A) P-2, Q-3, R-1, S-4
Coleoptera are characterized by hardened elytra, while Lepidoptera have wings covered in overlapping scales. Diptera are unique for having hindwings reduced to halteres for balance during flight. Hymenoptera utilize hamuli, which are tiny hooks that couple the fore and hind wings together. These morphological specializations are defining traits for each of these major endopterygote orders, reflecting their diverse evolutionary adaptations for flight and protection.

51. (A) Larval cell clusters that form adult structures during metamorphosis.
Imaginal discs are specialized clusters of undifferentiated cells found in the larvae of endopterygote insects. These discs remain quiescent during the larval stages but undergo rapid growth and differentiation during the pupal stage to form adult structures such as wings, legs, and antennae. This internal developmental mechanism is a hallmark of holometabolous insects, allowing for the drastic transformation from larva to adult.

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52. (C) Many species exhibit haplo-diploidy, where males develop from unfertilized eggs.
The Order Hymenoptera is characterized by a haplo-diploid sex determination system. In this system, females develop from fertilized eggs and are diploid, while males develop from unfertilized eggs and are haploid. This genetic mechanism is believed to have influenced the evolution of social behavior in the group. While many are social, the order also contains numerous solitary species and diverse lifestyles, including many beneficial parasitoids.

53. (A) Development proceeding via hemimetabolous metamorphosis
Lepidoptera undergo holometabolous development, featuring four distinct life stages: egg, larva, pupa, and adult. They are not hemimetabolous. Key characteristics include adults with a coiled proboscis formed by the maxillary galeae and wings covered in scales. Their eruciform larvae, or caterpillars, typically possess abdominal prolegs with crochets for grasping surfaces. The pupal stage is often protected by a cocoon or forms a naked chrysalis.

54. (D) Coleoptera
The presence of hardened forewings called elytra that meet in a straight line down the back is the defining characteristic of the order Coleoptera. Their larvae typically have a well-developed head capsule and three pairs of thoracic legs but lack abdominal prolegs. This combination of larval and adult features distinguishes beetles from other orders like Lepidoptera, which have prolegs, or Diptera, which often have legless larvae.

55. (B) It allowed life stages to use different niches, reducing competition.
Holometabolous development provides a significant evolutionary advantage by allowing the larval and adult stages to occupy different ecological niches. Larvae typically focus on feeding and growth, often consuming different food sources than the adults, which focus on dispersal and reproduction. This separation reduces intraspecific competition for resources and has contributed to the enormous diversity and success of endopterygote insects in various environments.

56. (C) Noctuidae
The family Noctuidae is one of the largest and most economically significant families in the Order Lepidoptera. Its members include notorious agricultural pests such as cutworms, armyworms, and various borers. Adults are typically nocturnal and possess a tympanal organ on the metathorax, which helps them detect the ultrasonic calls of bats. This sensory adaptation is a key survival mechanism for many species within this diverse family.

57. (D) Pyralidae adults typically rest with their wings held vertically over their back, resembling a sail.
Pyralidae is a large family of moths that typically rest with their wings folded flat or held in a tent-like fashion over the body, rather than vertically like butterflies. Other statements are correct: Gelechiidae includes the pink bollworm, Crambidae contains many significant stem borers, and Noctuidae is a massive family comprising major pests like armyworms. Understanding resting postures is helpful for field identification of these groups.

58. (A) The anterior elongation of the head into a pronounced rostrum or snout
The family Curculionidae, or weevils, is uniquely distinguished by a head that is elongated into a rostrum or snout. The chewing mouthparts are located at the very tip of this structure, allowing the insect to bore into plant tissues for feeding or to excavate sites for egg-laying. This morphological specialization is a key diagnostic feature that separates weevils from other major families within the order Coleoptera.

59. (D) Curculionidae - Predatory adults with filiform antennae and aquatic larvae
Curculionidae, known as weevils, are primarily phytophagous insects, not predators. They are characterized by having geniculate or elbowed antennae and larvae that are typically legless and develop inside plant tissues. They are not known for having aquatic larvae. Other pairs are correct: Chrysomelidae are leaf feeders, Coccinellidae are mostly predatory with specific tarsal formulas, and Scarabaeidae have lamellicorn antennae and C-shaped larvae.

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60. (A) They cause tissue necrosis and fruit drop via piercing-sucking feeding.
Members of the family Pentatomidae, or stink bugs, use their piercing-sucking mouthparts to feed on plant juices. Their feeding can lead to significant damage, including tissue necrosis, deformation of developing seeds, and premature fruit drop. In addition to physical damage, they may inject enzymes that further degrade plant tissue. While some pentatomids are predatory and beneficial, many are major agricultural pests on various crops.

61. (A) One or more rows of small spines running along the length of the hind tibiae
Cicadellidae, commonly known as leafhoppers, are distinguished by the presence of one or more rows of small, prominent spines on their hind tibiae. This morphological feature is a consistent diagnostic character for the family. Leafhoppers are significant agricultural pests that feed on plant sap and are well-known for their ability to transmit various plant pathogens, including viruses and phytoplasmas, to a wide range of host plants.

62. (C) Aleyrodidae
Aleyrodidae, or whiteflies, are unique among exopterygotes because they possess a quiescent, non-feeding final nymphal instar often referred to as a "pupa." This stage is structurally distinct and remains sessile on the leaf surface. Whiteflies are major agricultural pests, not only due to their direct feeding on sap but also because they serve as primary vectors for many devastating plant viruses, particularly begomoviruses.

63. (D) Aphididae
Aphididae, or aphids, are sap-sucking insects that excrete large amounts of sugar-rich honeydew. This honeydew accumulates on plant surfaces, providing a substrate for the growth of black sooty mold. Heavy infestations lead to rapid wilting, leaf curling, and overall reduced plant vigor. Aphids are also highly significant vectors for numerous plant viruses, further increasing their status as major pests in both agricultural and horticultural systems.

64. (C) Microscopic egg endoparasitoids used in biological control.
Trichogrammatidae is a family of minute wasps that are highly valued in biological control programs. They function as egg endoparasitoids, where the female wasp lays its eggs inside the eggs of various pest insects, particularly Lepidoptera. The developing wasp larva consumes the host egg's contents, preventing the pest from hatching. Because of their effectiveness and ease of mass-rearing, they are widely used in integrated pest management.

65. (B) I and II
Crustaceans are distinguished from other arthropods by possessing two pairs of antennae. Chilopods, or centipedes, are characterized by having the first pair of trunk appendages modified into venom claws for hunting. However, diplopods, or millipedes, are distinguished by having two pairs of legs on most of their body segments, not just one. This diplosegmentation is a primary structural feature that separates millipedes from the predatory centipedes.

66. (D) Braconids lack a costal cell and have only one recurrent vein in the forewing.
Braconidae and Ichneumonidae are closely related families of parasitic wasps, but they can be distinguished by wing venation. Braconids typically lack a costal cell because the costa and radius are fused. Furthermore, they have only one recurrent vein in the forewing, whereas Ichneumonids possess two. This microscopic detail is a reliable diagnostic character used by taxonomists to separate these two important groups of biological control agents.

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67. (A) Syrphidae
Syrphidae, or hoverflies, are dual-purpose insects in agricultural ecosystems. The adults are significant pollinators of various crops as they feed on nectar and pollen. In contrast, the larvae of many syrphid species are voracious predators, primarily feeding on aphids and other soft-bodied insects. This combination of pollination and biological control makes syrphids exceptionally beneficial in integrated pest management strategies designed to reduce reliance on chemical pesticides.

68. (C) The outer surface of the hind tibiae
The corbicula, or pollen basket, is a specialized anatomical structure found in certain members of the family Apidae, such as honey bees and bumblebees. It consists of a concave area on the outer surface of the hind tibiae, surrounded by stiff hairs that secure the collected pollen. This adaptation is essential for the efficient transport

of large quantities of pollen back to the colony to feed the developing larvae.

69. (A) Standardized genomic sequencing to identify species accurately.
DNA barcoding is a taxonomic method that uses a short, standardized genetic marker to identify an organism as belonging to a particular species. In insects, this typically involves sequencing a specific region of the mitochondrial genome. This approach allows for rapid and accurate identification, even for specimens that are damaged, immature, or part of a cryptic species complex where morphological differences are nearly impossible to distinguish.

70. (C) A is true but R is false.
The mitochondrial COI gene is indeed the standard marker for animal DNA barcoding because it exhibits high interspecific variation. However, the reason provided is incorrect; the COI gene does not have a very low rate of evolution that makes it identical across different orders. Instead, it evolves at a rate that is ideal for distinguishing between species while remaining relatively conserved within a single species.

71. (B) Mitochondrial DNA typically undergoes rapid recombination during meiosis, preventing lineage tracking.
Mitochondrial DNA is generally inherited maternally and does not undergo the rapid recombination seen in nuclear DNA. This lack of recombination is actually an advantage for DNA barcoding, as it allows for clear lineage tracking and consistent sequence analysis. Other beneficial properties of mtDNA include the lack of introns, high copy numbers per cell, and ideal divergence rates for species-level identification across a wide range of taxa.

72. (C) A derived character state shared by two or more taxa and their most recent common ancestor
In phylogenetic analysis, a synapomorphy is a shared derived character that defines a monophyletic group. It is a trait that evolved in the most recent common ancestor of a group and was passed down to its descendants, distinguishing that clade from other lineages. Synapomorphies are the primary evidence used in cladistics to determine evolutionary relationships and to construct branching patterns in a phylogenetic tree or cladogram.

73. (D) Monophyletic
A monophyletic group, also known as a clade, consists of a common ancestor and all of its descendants. This type of grouping is the goal of modern cladistic analysis, as it accurately reflects the evolutionary history of the taxa involved. In contrast, paraphyletic groups exclude some descendants, and polyphyletic groups include members from different lineages without including their most recent common ancestor, leading to unnatural classifications.

74. (A) Apterygota, as it excludes winged descendants of its lineage.
Traditional classifications often recognize the group Apterygota for primarily wingless insects. However, modern cladistic analysis reveals that this group is paraphyletic because it excludes the Pterygota, which are the winged descendants of the original apterygote lineage. To be monophyletic, a group must include all descendants of a common ancestor. This realization has led to significant revisions in how taxonomists view the early evolution and relationship of hexapods.

75. (D) II and III
Diplurans are entognathous hexapods that lack eyes and possess characteristic abdominal cerci. Proturans are unique because they lack antennae and instead use their modified front legs for sensory purposes. Collembolans are wingless, and all entognathous orders undergo ametabolous development rather than holometabolous metamorphosis. These distinct morphological and developmental traits are used to define and differentiate these primitive hexapod lineages within the soil and litter ecosystems.

76. (A) They are primitive traits that do not provide evidence of recent common ancestry.
Symplesiomorphies are ancestral character states shared by several taxa. Because these traits were present long before the divergence of the groups being studied, they do not provide information about the specific branching order within a clade. Only shared derived characters, or synapomorphies, can identify recent common ancestry and resolve the internal relationships of a group. Relying on symplesiomorphies can

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lead to incorrect or overly broad taxonomic groupings.

77. (A) Willi Hennig
Willi Hennig was a German entomologist who is credited with formalizing the principles of phylogenetic systematics, or cladistics, in the mid-20th century. His work emphasized that taxonomic groups should only be based on shared derived characters (synapomorphies) to reflect true evolutionary history. This methodological shift revolutionized the field of biology, providing a rigorous and objective framework for reconstructing the tree of life and classifying organisms.

78. (C) The tree that requires the fewest total number of evolutionary changes (steps) to explain the observed character states
Maximum Parsimony is an optimality criterion based on the principle of simplicity. When constructing a phylogenetic tree, the parsimony method selects the topology that explains the observed data with the minimum number of character-state transitions. This approach assumes that the simplest evolutionary path is the most likely. It is a fundamental tool in cladistics for analyzing both morphological and molecular datasets to determine relationships among taxa.

79. (D) An outgroup is deliberately chosen from within the primary study group (ingroup) to calculate the rate of internal divergence.
An outgroup is a taxon that is known to be closely related to the study group (the ingroup) but is outside of it. It is used to root the tree and determine the direction of character evolution. Choosing an outgroup from within the ingroup would defeat its purpose. Other tools like bootstrapping and Maximum Likelihood are standard statistical methods used to assess confidence and model evolution in phylogenetic studies.

80. (D) P-4, Q-1, R-2, S-3
The collembolan furcula is held in place by a catch mechanism called the retinaculum. Johnston's organ is a sensory structure located in the pedicel of the antennae in true insects. The gnathal pouch is the internal cavity that encloses the mouthparts in entognathous hexapods. Anamorphosis is the developmental process where abdominal segments are added during successive molts, a unique characteristic seen in the primitive order Protura.

81. (B) Bayesian Inference
Bayesian Inference is a statistical method used in molecular systematics to estimate the posterior probability of a phylogenetic tree. It utilizes Markov chain Monte Carlo algorithms to explore a wide range of possible trees and parameters, given a specific model of evolution and the observed data. This approach provides a measure of support for different clades and has become highly popular due to its ability to handle complex evolutionary models efficiently.

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82. (D) Homologous structures inherited directly from a recent shared common ancestor
Homology refers to traits that are shared because they were inherited from a common ancestor. This is the opposite of homoplasy, which refers to similar traits that evolved independently. Homoplasy can result from convergent evolution, parallel evolution, or evolutionary reversals. Distinguishing between homology and homoplasy is a central challenge in phylogenetic reconstruction, as only homologous characters provide reliable information about the actual branching patterns of evolutionary history.

83. (A) It roots the tree, allowing for the determination of the direction of evolutionary change.
Rooting a phylogenetic tree is essential for interpreting the sequence of evolutionary events. By including an outgroup, which is a taxon known to have branched off before the common ancestor of the study group, researchers can establish which character states are ancestral and which are derived. This provides a temporal direction to the cladogram, allowing for a clearer understanding of how different lineages and their traits evolved over time.

84. (C) It manages complex models and provides clade support via posterior probabilities.
Bayesian inference offers a significant advantage over Maximum Parsimony by incorporating explicit statistical models of sequence evolution. This allows it to better handle complexities such as varying rates of mutation across different sites. Furthermore, it provides direct estimates of clade support through posterior probabilities, offering a more nuanced and statistically grounded interpretation of the resulting phylogenetic

tree compared to the simpler, non-probabilistic approach of parsimony.

85. (A) I, II and III
Members of the subclass Apterygota, such as silverfish, exhibit several primitive biological traits. They undergo ametabolous development, meaning they have no distinct metamorphosis and simply increase in size. Uniquely, they continue to molt throughout their lives, even after reaching sexual maturity. Furthermore, they typically utilize indirect sperm transfer, where the male deposits a spermatophore that is later picked up by the female, rather than through direct copulation.

86. (D) The junior homonym is invalid and must be replaced by a new substitute name.
Under the rules of the International Code of Zoological Nomenclature, two different genera cannot share the same name. If a genus name is found to be identical to one previously established, the later name is considered a junior homonym and is deemed invalid. The author must then propose a new replacement name to ensure each genus has a unique and stable identifier within the global system of zoological nomenclature.

87. (B) Convergent evolution
The raptorial forelegs of praying mantises and mantidflies are highly similar in structure and function, being adapted for grasping prey. However, these two groups belong to distantly related orders. Their similar legs are a result of convergent evolution, where independent lineages evolve similar traits in response to similar environmental pressures or ecological niches. Such traits are considered homoplasies rather than synapomorphies because they do not reflect recent shared ancestry.

88. (C) It utilized the thoracic exoskeleton's elasticity for higher wing-beat frequencies.
Indirect flight muscles do not attach directly to the wings but instead deform the thoracic box to move them. This mechanism allows insects to utilize the elastic properties of the exoskeleton to store and release energy, facilitating much higher wing-beat frequencies than are possible with direct muscle attachment alone. This evolutionary advancement contributed to the superior flight capabilities seen in more derived insect orders like Diptera and Hymenoptera.

89. (D) Diplura possess well-developed compound eyes and three long caudal filaments.
Diplura are entognathous hexapods that are uniquely characterized by the total absence of eyes. They possess a pair of abdominal cerci, which can be either thread-like or forceps-like, but they do not have three caudal filaments. Other statements are accurate: Proturans exhibit anamorphosis and lack antennae, Collembolans have a collophore, and Zygentoma are ametabolous insects often covered in silvery scales. These traits are key to identifying different primitive hexapod groups.

90. (A) Both pairs of wings are narrow, strap-like, and fringed with long marginal hairs.
The order Thysanoptera, or thrips, is characterized by its very narrow, strap-like wings that possess a reduced venation and are fringed with long hairs. This fringe increases the effective surface area of the wing for flight in small insects by taking advantage of the viscosity of air. This unique wing morphology is a defining characteristic of the order and is easily observed under magnification during taxonomic identification.

91. (B) Tarsi possessing an apparent 4-4-4 segmentation formula
Scarabaeidae are characterized by lamellicorn antennae, C-shaped larvae known as white grubs, and often exhibit significant sexual dimorphism. However, their tarsal formula is typically 5-5-5, not the pseudotrimerous 4-4-4 formula seen in families like Coccinellidae or Chrysomelidae. The 5-5-5 arrangement is a standard feature for most scarabs, reflecting their robust body plan and diverse ecological roles, ranging from dung burial to plant feeding.

92. (B) Autapomorphy - A derived trait unique to a single taxon
An autapomorphy is a derived character state that is unique to a specific terminal lineage. While it helps define that taxon, it does not provide information about relationships with other groups. In contrast, synapomorphies are shared derived traits used to group taxa. Other terms include polyphyly, which refers to an unnatural group from multiple ancestors, and homology, which describes traits shared due to common ancestry. Cladograms represent relationships rather than chronological time.

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93. (A) The shift to obligate ectoparasitism on vertebrate hosts.
The evolutionary loss of wings, or apterism, in orders like Siphonaptera (fleas) and Phthiraptera (lice) is primarily an adaptation to an ectoparasitic lifestyle. Wings are unnecessary and can be a hindrance when moving through the fur or feathers of a host animal. This secondary loss of flight allows these insects to become more specialized for clinging to their hosts and navigating dense host coverings, representing a significant evolutionary trade-off for survival.

94. (C) The assignment of the identical name to two or more distinct taxa
Homonymy occurs in zoological nomenclature when the same name is applied to different biological entities. This can happen at various taxonomic levels, such as when two different species in the same genus are mistakenly given the same specific name. The ICZN established the Principle of Homonymy to resolve these conflicts, typically by invalidating the more recently published name (the junior homonym) and requiring it to be replaced by a unique substitute.

95. (D) A modified, extensible labium used for capturing prey.
While both Ephemeroptera and Odonata have aquatic immature stages with external wing pads, the odonate naiad possesses a unique predatory adaptation. This is a highly modified, extensible labium, often called a "mask," which can be rapidly projected forward to seize prey. This structure is a definitive diagnostic feature of the order Odonata in its nymphal stage and reflects their specialized role as aggressive underwater predators in various aquatic environments.

96. (C) Dipterans utilize a specialized jugal lobe to physically lock their functional forewings to their halteres.
Dipterans have only one pair of functional wings on the mesothorax, while the hindwings are modified into halteres. Since there is only one pair of wings for flight, they do not require a wing-coupling mechanism to link fore and hind wings. Coupling mechanisms like the frenulum in Lepidoptera or hamuli in Hymenoptera are used to coordinate the two pairs of wings to function as a single aerodynamic unit, improving flight efficiency.

97. (B) Hemimetabola - Exopterygota
The classification of the subclass Pterygota into Hemimetabola and Holometabola corresponds to the terms Exopterygota and Endopterygota. Hemimetabolous insects (Exopterygota) undergo incomplete metamorphosis with external wing development in nymphs. Holometabolous insects (Endopterygota) undergo complete metamorphosis with internal wing development and a pupal stage. These developmental pathways represent the two major strategies for growth and transformation within the winged insect lineages, each with distinct ecological advantages and life histories.

98. (D) It allows targeting specific stages as larvae and adults use different niches.
Understanding holometabolous development is crucial in pest management because the larvae and adults often occupy different habitats and have different feeding habits. This allows for more precise control strategies, such as using soil treatments for larvae and foliar sprays for adults, or biological control agents that specifically target the most vulnerable or damaging stage. By recognizing these niche differences, pest control can be more effective, economical, and environmentally sustainable.

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99. (A) Neuroptera
Neuroptera, which includes lacewings and antlions, is an order that belongs to the Endopterygota, meaning they undergo complete metamorphosis with a pupal stage. The other orders listed—Phthiraptera (lice), Blattodea (cockroaches and termites), and Dermaptera (earwigs)—are all members of the Exopterygota, characterized by incomplete metamorphosis and external wing development. Distinguishing between these two major groups is a fundamental step in the classification and study of winged insect diversity.

100. (A) Both A and R are true and R is the correct explanation of A.
Endopterygote insects are the most diverse group of organisms on Earth, and their success is largely attributed to complete metamorphosis. By having a larval stage dedicated to feeding and an adult stage specialized for reproduction and dispersal, they can utilize different resources and environments. This reduces competition within the same species, allowing for greater population densities and the colonization of a wide variety

of ecological niches in terrestrial and aquatic systems.

101. (A) The worker and soldier castes consist exclusively of sterile individuals of both sexes.
In the Order Isoptera (termites), the worker and soldier castes are made up of sterile males and females, which is a unique feature compared to social Hymenoptera where these castes are exclusively female. Termite colonies are long-lived and have a perennial structure centered around a king and queen. The soldiers are specialized for defense and are typically wingless, while workers handle foraging, nest maintenance, and care for the developing young.

102. (D) A pair of cornicles located on the dorsal posterior abdomen.
The family Aphididae is unequivocally identified by the presence of cornicles, which are two small tubes located on the rear of the abdomen. These structures are used to exude defensive fluids and alarm pheromones. While other features like sap-feeding and soft bodies are common, cornicles are a unique diagnostic character for aphids. Their presence is a primary indicator for entomologists when identifying these significant agricultural pests and virus vectors.

103. (B) Elytra - Orthoptera
Orthoptera are characterized by having tegmina, which are thickened, leathery forewings, rather than the hardened elytra seen in Coleoptera. Other pairs are correct: Diptera possess halteres for balance, Hymenoptera use hamuli to couple their wings, and Collembola are known for their furcula used for jumping. Correctly identifying these specialized morphological structures is essential for the proper classification of insect orders and for understanding their diverse functional adaptations in the environment.

104. (C) To bypass excess water and sugar, concentrating nutrients.
The filter chamber is a specialized physiological adaptation found in many sap-sucking Hemiptera. Because plant sap is mostly water and sugar with very little protein, these insects must consume large quantities to obtain enough nutrients. The filter chamber allows them to quickly shunt the excess water and sugar directly from the foregut to the hindgut, concentrating the essential nutrients in the midgut for efficient absorption while producing honeydew as a byproduct.

105. (D) Hemelytra forewings and a beak arising from the head's anterior.
Heteroptera, a suborder of Hemiptera, is characterized by having hemelytra, where the base of the forewing is thickened and the tip is membranous. Additionally, their beak, or rostrum, typically arises from the anterior part of the head. In contrast, other hemipterans often have uniform wings and a beak that arises further back. These morphological differences are key to distinguishing between the diverse groups of true bugs, which include both pests and predators.

106. (A) Obligate apterous ectoparasites with specialized tarsal claws.
The order Phthiraptera consists of lice, which are secondarily wingless insects that live as obligate ectoparasites on the bodies of birds and mammals. They have evolved specialized tarsal claws to securely grasp the fur or feathers of their hosts. Lice undergo hemimetabolous development and spend their entire life cycle on the host, feeding on blood, skin debris, or secretions. This extreme specialization has made them highly successful in their unique parasitic niche.

107. (B) Tospoviruses
Certain species of thrips in the order Thysanoptera are the only known vectors for plant viruses in the genus Tospovirus, such as the Tomato Spotted Wilt Virus. These viruses can cause devastating crop losses worldwide. The relationship is highly specific, as the virus must be acquired by the thrips during its larval stage to be transmitted by the adult. This interaction makes thrips management a critical component of disease control in many high-value agricultural crops.

108. (A) Diptera
The modification of the hindwings into halteres is a definitive synapomorphy of the order Diptera, which includes true flies, mosquitoes, and gnats. Halteres are small, club-like structures that act as gyroscopic sensors, providing essential feedback for balance and coordination during flight. This unique adaptation allows dipterans to perform complex aerial maneuvers and is a key reason for their evolutionary success. The term "Diptera" itself reflects this "two-winged" condition, which is a primary diagnostic character.

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109. (A) Lepidoptera - Eruciform
Lepidopteran larvae are typically eruciform, which means they are caterpillar-like with a cylindrical body, a well-developed head capsule, thoracic legs, and abdominal prolegs. This larval form is adapted for crawling on and consuming plant foliage. Other orders have different typical larval forms, such as the apodous (legless) larvae of many Diptera or the campodeiform (active and predatory) larvae of some Neuroptera. Recognizing these larval types is essential for the identification and management of insect pests.

110. (B) P-4, Q-1, R-2, S-3
Neuroptera are known for their extensive wing venation and predatory larvae. Siphonaptera are laterally compressed, wingless ectoparasites. Trichoptera larvae are famous for constructing protective cases in aquatic environments. Strepsiptera have a unique life cycle where males are winged but females are often wingless and live as endoparasites within other insects. These diverse traits illustrate the wide range of morphological and ecological specializations found within the different endopterygote orders during their evolution.

111. (D) The consistent presence of heavily sclerotized elytra protecting the abdomen
Hymenoptera are characterized by mandibulate mouthparts often modified for lapping, an ovipositor that may be modified into a sting, and a haplo-diploid sex determination system. However, they do not possess elytra. Elytra are the hardened forewings found in beetles (Coleoptera). In Hymenoptera, both pairs of wings are membranous and are typically coupled together during flight by small hooks called hamuli. This fundamental wing difference is a key character for distinguishing between these two major insect orders.

112. (C) In all adult Lepidoptera, functional mandibles are completely absent without exception.
While most adult Lepidoptera possess a coiled proboscis and lack mandibles, there is a notable exception in the primitive family Micropterigidae. Adults in this family retain functional chewing mandibles used for eating pollen. In the vast majority of other Lepidoptera, the mandibles are vestigial or absent, and the mouthparts are dominated by the elongated maxillary galeae. Understanding these basal exceptions is important for a complete picture of the evolutionary history and morphological diversity of the order.

113. (B) Neuroptera
An insect with four membranous wings featuring a complex network of veins and a terrestrial larva with sickle-shaped jaws is a classic description of the order Neuroptera. This group includes lacewings and antlions, whose larvae are often called “aphid lions” or “doodlebugs” due to their predatory habits. The intricate wing venation and specialized larval mouthparts are key diagnostic features that separate them from other orders like Odonata, which have aquatic larvae and different wing structures.

114. (D) High genetic relatedness among sisters favors cooperative care.
The haplo-diploid system in Hymenoptera results in a unique genetic situation where full sisters share 75% of their genes on average, which is higher than the 50% shared with their own potential offspring. According to kin selection theory, this high relatedness makes it more “evolutionarily profitable” for sisters to help the queen raise more sisters rather than reproducing themselves. This genetic predisposition is believed to be a major factor in the multiple independent origins of eusociality within this order.

115. (C) Direct flight muscle attachment → Development of the third axillary sclerite → Refined indirect flight muscle utilization
The evolution of insect flight began with direct flight muscles attached to the wing base, as seen in Paleoptera. A key advancement was the emergence of the third axillary sclerite, which allowed for wing folding and led to the Neoptera. Finally, the shift toward indirect flight muscles, which move the wings by vibrating the thorax, allowed for the extremely high wing-beat frequencies and refined aerial agility characteristic of more advanced and diverse insect orders.

116. (C) Noctuidae
Members of the family Noctuidae possess specialized tympanal organs located on the metathorax. these organs are finely tuned to detect the high-frequency echolocation pulses emitted by insectivorous bats. This sensory adaptation allows the moths to perform evasive maneuvers in flight, such as dropping suddenly or

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spiraling, to avoid predation. This evolutionary arms race between bats and moths has led to highly sophisticated auditory systems in many nocturnal lepidopteran lineages, particularly within the noctuids.

117. (A) Crambids possess a specific tympanal organ structure known as the praecinctorium, which Pyralids lack.
Crambidae and Pyralidae are closely related families within the superfamily Pyraloidea, but they can be distinguished by internal and external features. One primary character is the praecinctorium, a structural component of the abdominal tympanal organ that is present in Crambids but absent in Pyralids. Additionally, differences in the morphology of the wing venation and the structure of the male genitalia are used by taxonomists to accurately classify species into these two distinct and diverse families.

118. (D) Small moths including pests like pink bollworm and potato tuber moth.
The family Gelechiidae is a large group of small, often inconspicuous moths that includes several major agricultural pests. Notable members include the pink bollworm, which is a significant pest of cotton, and the potato tuber moth. Their larvae have various habits, such as leaf mining, leaf rolling, or boring into seeds and tubers. Identifying these pests and understanding their life cycles is critical for developing effective management strategies in many important food and fiber crops worldwide.

119. (B) Gelechiidae - Helicoverpa armigera (Cotton bollworm)
Helicoverpa armigera, the cotton bollworm, belongs to the family Noctuidae, not Gelechiidae. Other pairs are correct: Spodoptera frugiperda is a noctuid, Chilo partellus is a crambid, and Corcyra cephalonica is a pyralid. Distinguishing between these families is important because they often require different management approaches. Misidentifying a pest's family can lead to ineffective control measures, as their biology, host range, and susceptibility to various insecticides or biological control agents can vary significantly.

120. (C) Hindwings strictly possessing a jugum for wing coupling with the forewing
Pyralidae moths typically use a frenulum-retinaculum system for wing coupling, rather than a jugum. A jugum is a more primitive coupling mechanism found in basal lepidopteran lineages like Hepialidae. Other features of Pyralidae include a scaled proboscis, tympanal organs at the base of the abdomen, and adults that are generally small to medium-sized with a characteristic resting posture. These traits are used collectively by entomologists to identify and study this economically important family of moths.

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121. (D) It houses the chewing mouthparts at its tip, facilitating feeding on internal plant tissues and excavating oviposition sites.
The prominent rostrum of weevils (Curculionidae) is a specialized adaptation for their phytophagous lifestyle. By having the mouthparts at the tip of this elongated snout, they can penetrate deep into seeds, fruits, or stems to feed on nutritious internal tissues. Furthermore, females use the rostrum to bore holes into host plants, where they then deposit their eggs, ensuring the developing larvae have immediate access to food and protection within the plant's structure.

122. (A) All species within the family are strictly carnivorous, making them universally beneficial in agriculture.
While most Coccinellidae (ladybugs) are beneficial predators of aphids and scale insects, not all are carnivorous. The subfamily Epilachninae consists of phytophagous species that can be serious agricultural pests, such as the Mexican bean beetle. Therefore, the family as a whole is not universally beneficial. Most coccinellids are characterized by their convex body, bright colors, and specific tarsal formula, and they play a vital role in natural and managed ecosystems as both predators and occasional pests.

123. (B) Scarabaeidae - Robust with lamellicorn antennae and distal leaf plates
Scarabaeidae are robust beetles easily recognized by their lamellicorn antennae, which end in several flattened, leaf-like plates that can be spread apart like a fan. This antenna type is a primary diagnostic character for the family. In contrast, Curculionidae have a snout and elbowed antennae, while Coccinellidae have a specific tarsal formula and body shape. Understanding these distinct morphological features is key to the rapid and accurate identification of major beetle families in the field.

124. (A) Leaf beetles whose larvae and adults are voracious defoliators.
The family Chrysomelidae, or leaf beetles, is economically significant because both the adult beetles and their larvae feed on the foliage of a wide variety of plants. Many species are specialized pests of major crops, causing extensive defoliation that can significantly reduce yields. Because of their diversity and high reproductive potential, leaf beetles are a constant challenge for farmers and are a major target of integrated pest management programs in many different agricultural systems.

125. (A) II and III
Curculionidae, or weevils, are distinguished by having geniculate (elbowed) antennae that often end in a distinct club. Additionally, their larvae are typically apodous, meaning they lack legs, and have a curved, grub-like appearance as they develop inside plant tissues. Weevils belong to the suborder Polyphaga, not Adephaga. These characteristic antenna and larval traits are essential for identifying weevils and for understanding their highly specialized life histories as internal plant feeders and significant agricultural pests.

126. (B) 4-4-4
Coccinellidae possess a tarsal formula that appears to be 3-3-3 but is actually 4-4-4, a condition known as pseudotrimerous. The third tarsal segment is very small and hidden within the lobes of the second segment. This anatomical detail is an important diagnostic character for the family. While it may seem minor, such consistent structural features are the foundation of systematic entomology, allowing scientists to accurately classify and distinguish between the vast number of beetle species.

127. (D) Coccinellidae
Coccinellidae is the beetle family most renowned for its predatory behavior and use in biological control. Many species, such as those in the genus Coccinella, are highly effective at suppressing populations of aphids, mealybugs, and scale insects. Because of their voracious appetite and ability to reproduce quickly, they are often mass-reared and released or encouraged in agricultural fields as a natural alternative to chemical insecticides, making them a cornerstone of sustainable pest management.

128. (C) Exuding defensive fluids containing alarm pheromones and wax.
Cornicles are unique structures found on the abdomen of aphids. They are not used for excreting honeydew or for reproduction. Instead, they serve a defensive function by secreting a waxy fluid that can harden to impede predators. More importantly, this fluid often contains alarm pheromones that signal nearby aphids to drop from the plant or move away, thereby increasing the survival of the colony in the face of an immediate threat from a predator or parasitoid.

129. (B) They are holometabolous insects with pupal stages like Diptera.
Whiteflies (Aleyrodidae) are hemimetabolous insects, not holometabolous. Although they have a quiescent final nymphal stage that is often called a "pupa," it is not the same as the pupal stage found in orders like Diptera or Lepidoptera. Whiteflies undergo incomplete metamorphosis where the nymphs resemble the adults more than they resemble a typical larva. This "pupa-like" stage is a specialized adaptation within the exopterygote lineage, particularly among the more sessile groups of sap-sucking insects.

130. (A) Both A and R are true and R is the correct explanation of A.
Hopperburn is a severe condition caused by certain leafhoppers (Cicadellidae) that feed on the phloem of plants. As they feed, they cause mechanical damage and inject toxic saliva that clogs the plant's vascular tissues. This prevents the normal transport of water and nutrients, leading to yellowing, browning, and eventually the death of leaf tissue, starting from the edges. This symptom is a direct result of the insect's specialized feeding physiology and can cause devastating losses in many crops.

131. (A) A large, triangular or shield-shaped scutellum
The family Pentatomidae is characterized by a prominent scutellum, which is the posterior part of the mesonotum. In these insects, it is large and triangular, often extending well back over the abdomen, giving them their characteristic "shield bug" appearance. This feature is a primary diagnostic character for the family and is often brightly colored or patterned. The scutellum provides protection and serves as a visible marker for identifying these common and often economically important true bugs.

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132. (C) Cicadellidae - Primary vectors of Tungro viruses and various phytoplasmas
Cicadellidae, or leafhoppers, are among the most significant vectors of plant diseases. They are responsible for transmitting a wide range of pathogens, including the rice tungro viruses and various phytoplasmas that cause diseases like aster yellows. Their ability to move quickly between plants and their specialized feeding on vascular tissues make them highly efficient vectors. Understanding these vector relationships is essential for managing the spread of devastating plant diseases in both agricultural crops and natural plant communities.

133. (A) Rapid overlapping generations of clones trigger explosive outbreaks.
Parthenogenesis allows aphids to reproduce without mating, with females giving birth to live, genetically identical female offspring. In favorable conditions, this can lead to incredibly rapid population growth, with new generations being produced in just a few days. These overlapping generations and clonal reproduction mean that aphid populations can reach outbreak levels very quickly, overwhelming both the plant's defenses and the natural enemies that might otherwise keep them in check, making them formidable agricultural pests.

134. (D) Pentatomidae
While many sap-sucking Hemiptera in the suborders Auchenorrhyncha and Sternorrhyncha possess a filter chamber to handle their liquid diet, the Pentatomidae (stink bugs) generally do not. This is likely because their diet, while still involving plant fluids, often includes more varied or concentrated sources like seeds and fruits, which may not require the extreme water-bypassing mechanism of a filter chamber. This physiological difference reflects the diverse feeding strategies and diets found within the different groups of the order Hemiptera.

135. (C) II and III
Trichogrammatidae are minute wasps characterized by having three-segmented tarsi and broad, often fringed wings with very little venation. These tiny insects are egg parasitoids, not adult parasites, and they are definitely not phytophagous. Their unique morphology is an adaptation to their extremely small size and their lifestyle of seeking out and developing inside the eggs of other insects. These traits are key for identifying this family, which is one of the most important groups in biological control.

136. (C) The lack of the 2nd recurrent vein (vein 2m-cu) in the forewing of Braconidae
Braconidae and Ichneumonidae are both important families of parasitic wasps, but they can be consistently distinguished by their wing venation. The most reliable character is the presence or absence of the second recurrent vein in the forewing. Braconids lack this vein, while Ichneumonids possess it. This small but consistent difference is used by taxonomists to separate thousands of species into their correct families, which is vital for research in ecology, evolution, and biological control in agriculture.

137. (D) Syrphidae
The "spurious vein" is a unique taxonomic character found in the wings of many hoverflies in the family Syrphidae. This is a vein-like thickening that is not connected to the other veins at either end. It is a highly reliable diagnostic feature for the family, allowing entomologists to quickly identify syrphids from other similar-looking flies or bees. This specialized wing structure is one of several anatomical features that define this diverse and ecologically beneficial group of dipterans.

138. (A) The specialized corbicula (pollen basket) is located on the highly modified anterior surface of the fore tibiae.
The corbicula, or pollen basket, is actually located on the outer surface of the hind tibiae in bees of the family Apidae, not on the fore tibiae. Other statements are correct: the family includes vital pollinators, they have a specialized maxillo-labial complex for feeding, and many exhibit complex social behaviors. Correctly identifying the location of specialized structures like the corbicula is essential for understanding the functional morphology of bees and their role as highly efficient collectors of pollen.

139. (B) Braconidae - Endoparasitoids of Lepidoptera and other orders
Braconidae is a large family of wasps that are primarily endoparasitoids, meaning their larvae develop inside the bodies of other insects, eventually killing them. They target a wide range of hosts, including many lepidopteran pests, making them extremely important in natural and applied biological control. Other

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pairs are incorrect: Trichogrammatidae are egg parasitoids, Syrphidae are aphid predators as larvae, and Apidae are pollinators, not predators. Understanding these ecological roles is crucial for effective integrated pest management.

140. (D) P-2, Q-3, R-1, S-4
Trichogrammatidae are minute egg parasitoids. Apidae are social or solitary foragers of nectar and pollen. Syrphidae have slug-like larvae that feed on aphids. Braconidae often spin silken cocoons on or near their host after completing their development inside them. This matching illustrates the diverse life histories and morphological traits of some of the most important families of beneficial insects in agricultural ecosystems, each playing a unique role in pollination or natural pest suppression.

141. (A) As highly effective, mobile predators deployed to quickly reduce dense aphid populations on crops.
Syrphid larvae are voracious predators of aphids, and their presence can significantly reduce pest populations in a short amount of time. Because they are mobile and have a high consumption rate, they are excellent candidates for biological control. Encouraging natural syrphid populations by providing floral resources for the adults is a common strategy in integrated pest management to help keep aphid numbers below economic thresholds without the need for intensive chemical interventions.

142. (C) The use of a standardized, short genomic sequence to identify specimens accurately and assign them to known or novel species.
DNA barcoding provides a rapid and standardized way to identify biological specimens by comparing a short, specific DNA sequence to a global database. This method is particularly useful in entomology for identifying cryptic species, different life stages, or damaged specimens where traditional morphology may be insufficient. By using a universal genetic marker, scientists can quickly and accurately catalog biodiversity and monitor for invasive species, greatly enhancing the speed and precision of taxonomic and ecological research.

143. (D) It has favorable divergence rates between species and low variation within.
The COI gene is an ideal marker for DNA barcoding because its sequence changes quickly enough to distinguish between closely related species but slowly enough that individuals within the same species have very similar sequences. This creates a "barcode gap" that makes identification reliable. Additionally, the gene's presence in the mitochondria and its lack of introns make it easy to work with in the laboratory, further supporting its use as the global standard for animal species identification.

144. (C) The mutation rate of mtDNA is significantly slower than that of most nuclear genes, making it useless for recently diverged species.
Mitochondrial DNA actually has a faster mutation rate than most nuclear DNA, which makes it particularly useful for distinguishing between recently diverged species. This high rate of evolution, combined with other factors like maternal inheritance and high copy number, makes mtDNA an excellent tool for molecular systematics and DNA barcoding. The statement that it is slower and useless for recent species is incorrect and ignores the primary reasons why mtDNA is so widely used in biology.

145. (A) I, III, IV and V
The standard DNA barcoding procedure for insects involves using PCR to amplify a 658 base-pair region of the COI gene, which is then sequenced using the Sanger method. The resulting sequence is compared against global databases like BOLD for identification. This process does not require the destruction of the entire genome; in fact, preserving the original DNA is important for further research. These standardized steps have allowed for the creation of a massive, global library of life's genetic signatures.

146. (D) It simplifies alignment as there are rarely indels causing frame shifts.
The absence of introns in the COI gene is a major advantage for DNA barcoding because it means the sequence is a continuous coding region. This lack of non-coding gaps, or indels, makes it much easier to align sequences from different species and ensures that the reading frame remains consistent. Simplified alignment reduces the potential for errors in computational analysis, making the identification of species more accurate and the construction of phylogenetic trees more reliable and straightforward.

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147. (A) Sequencing COI regions to identify deep genetic divergence in cryptic species.
DNA barcoding is used to uncover cryptic species, which are groups of organisms that look identical but are genetically distinct and reproductively isolated. In the case of pests with different resistance profiles, barcoding can reveal if what was thought to be one species is actually two or more. This information is critical for pest management, as different species may require different control strategies, and understanding their genetic diversity can lead to more effective and targeted interventions.

148. (C) Synapomorphy
A synapomorphy is a shared derived character state that is unique to a group and its most recent common ancestor. In cladistics, synapomorphies are the only characters that can provide evidence for the existence of a monophyletic group or clade. By identifying these shared derived traits, scientists can reconstruct the branching patterns of evolution and determine the relationships between different taxa. This concept is fundamental to the modern, objective approach to biological classification and phylogenetic systematics.

149. (A) Monophyly includes an ancestor and all descendants; paraphyly excludes some.
The difference between monophyletic and paraphyletic groups lies in whether all descendants of a common ancestor are included in the group. A monophyletic group is a complete evolutionary unit, consisting of an ancestor and all its descendants. A paraphyletic group is incomplete, as it leaves out one or more of the descendant lineages. In modern systematics, monophyletic groups are the only ones considered to be natural and valid for a classification that truly reflects evolutionary history.

150. (D) Symplesiomorphies provide strong evidence for monophyletic clades.
Symplesiomorphies are ancestral character states that are shared by many different groups, and therefore they cannot be used to define a specific monophyletic clade. Only shared derived characters, or synapomorphies, provide the necessary information to group taxa together based on recent common ancestry. Relying on symplesiomorphies would result in broad, unnatural groupings that do not accurately reflect the actual branching order of evolution, which is the primary goal of cladistic analysis and modern systematics.

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151. (B) Phylogenetic Systematics (Cladistics) - Willi Hennig
Willi Hennig was the visionary biologist who developed the principles of phylogenetic systematics, now commonly known as cladistics. His methodology changed biology by insisting that classification must be based on the evolutionary history of organisms, specifically using shared derived characters (synapomorphies). This objective framework has become the standard for reconstructing the tree of life, allowing scientists to move beyond subjective overall similarity to a more rigorous and scientifically sound understanding of biological relationships and diversity.

152. (C) Polyphyletic
A polyphyletic group is one that includes taxa from different evolutionary lineages but does not include their most recent common ancestor. Such groups are considered "unnatural" because they are often based on convergent characters that evolved independently rather than on shared ancestry. In modern systematics, polyphyletic groups are avoided because they do not represent the true history of life. Identifying and correcting these groups is a major task in the ongoing refinement of biological classification and phylogenetic trees.

153. (D) Traits represent homoplasy from convergent evolution via ecological pressure.
When unrelated organisms evolve similar traits, it is known as homoplasy, which often results from convergent evolution. This happens when different lineages face similar environmental challenges and independently evolve similar solutions. For example, the wings of birds and insects are homoplasies. In phylogenetic analysis, homoplasy can be confusing because it looks like a shared derived character but is not. Distinguishing between homology and homoplasy is critical for accurately reconstructing the evolutionary relationships and history of different species.

154. (A) Selecting the tree that minimizes the total number of character-state changes required to explain the observed data.
Maximum Parsimony is a classic method in phylogenetics based on the idea that the simplest

explanation is the most likely. When building a tree, it looks for the topology that requires the fewest evolutionary changes, or "steps." This approach assumes that evolutionary novelties are rare and that the tree with the least amount of change is the best hypothesis of the actual history. It is a powerful and widely used tool for analyzing both morphological and molecular data.

155. (C) II, III, I, IV
The standard workflow for molecular phylogenetics begins with DNA extraction and sequencing. Next, the sequences must be aligned to ensure that homologous sites are compared. Once aligned, an optimality criterion like parsimony or likelihood is used to calculate the best tree topology. Finally, the tree is statistically evaluated, often through bootstrapping, to determine the level of confidence in the different branches. This systematic approach ensures that the resulting phylogenetic tree is based on a rigorous and reproducible analysis.

156. (B) Statistically resampling datasets to estimate confidence in specific branches.
Bootstrapping is a statistical technique used to assess the reliability of the branches in a phylogenetic tree. It works by repeatedly creating new datasets from the original data and rebuilding the tree for each one. The frequency with which a particular clade appears in these "bootstrap replicates" is then used as a measure of support. A high bootstrap value indicates that a branch is strongly supported by the data, providing researchers with a way to quantify the certainty of their phylogenetic hypotheses.

157. (A) ML finds the most probable tree using mathematical models of substitution.
Maximum Likelihood is a sophisticated method for building phylogenetic trees that uses explicit statistical models of how DNA changes over time. It calculates the probability that a specific tree would produce the observed sequence data. By exploring different tree shapes and parameters, it finds the "most likely" tree. This approach is powerful because it can account for complexities in evolution that simpler methods like parsimony might miss, leading to more accurate and robust estimates of evolutionary relationships.

158. (C) Using an appropriate outgroup, a taxon closely related to but outside the ingroup.
Many computational methods produce "unrooted" trees, which show the relationships between taxa but not the direction of time. To determine which traits are ancestral and which are derived, the tree must be rooted. This is typically done by adding an outgroup, a species that is known to have branched off earlier than the groups being studied. The outgroup acts as a reference point, allowing scientists to see the path of evolutionary change and the true branching sequence of the lineages.

159. (D) Bootstrapping Resampling
While Maximum Parsimony, Maximum Likelihood, and Bayesian Inference are all optimality criteria used to choose the best tree from many possibilities, bootstrapping is not. Instead, bootstrapping is a statistical method used to evaluate the support or confidence for the branches within a tree after it has already been constructed using one of the other criteria. Understanding this distinction is important for properly interpreting the results of phylogenetic analyses and for knowing which tools to use for different parts of the research process.

160. (A) Protocerebrum
The protocerebrum is the largest and most anterior part of the insect brain. It contains the optic lobes, which are responsible for receiving and processing visual information from the compound eyes. This region is critical for vision, allowing the insect to perceive and respond to light, movement, and complex patterns in its environment. In addition to vision, the protocerebrum also houses centers for higher-level functions and integration, playing a central role in the insect's overall behavior and sensory perception.

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CHAPTER 02
Morphology

2015

1. What is the fundamental concept of tagmosis in arthropods?
(A) The separation of internal organs into distinct metameric compartments
(B) The developmental shedding of the old cuticle during the moulting process
(C) The fusion of internal endoskeletal structures to form the cranial tentorium
(D) The grouping of adjacent body segments into functional morphological units

2002

2. Which of the following best describes the primary body regions formed by tagmosis in the class Insecta?
(A) Cephalothorax and abdomen
(B) Prosoma, mesosoma, and metasoma
(C) Head, thorax, and abdomen
(D) Head, trunk, and pygidium

2016

3. In the generalized embryonic development of insects, how many primitive somites typically fuse to form the definitive insect head?
(A) Four
(B) Five
(C) Six
(D) Seven

2007

4. Match the insect tagmata in List-I with their primary physiological and ecological functions in List-II.
List-I: (Tagmata)
P. Head
Q. Thorax
R. Pregenital abdomen
S. Genital abdomen
List-II: (Functions)
1. Locomotion and structural support
2. Sensory perception and food ingestion
3. Reproduction and copulation
4. Visceral functions and digestion
(A) P-1, Q-2, R-3, S-4
(B) P-2, Q-1, R-4, S-3
(C) P-2, Q-4, R-1, S-3
(D) P-4, Q-1, R-2, S-3

2005

5. Which of the following structures is considered a non-segmental region located at the extreme anterior end of a primitive arthropod embryo?
(A) Acron
(B) Telson
(C) Labrum
(D) Clypeus

2024

6. Which statement INCORRECTLY characterizes the evolutionary trend of arthropod tagmosis?
(A) It involves the anatomical specialization of appendages on specific segments
(B) It leads to regional specialization of the body for distinct biological functions
(C) It results in an increased number of identical, unspecialized body segments
(D) It is often accompanied by the concentrated fusion of segmental ganglia

2015

7. The insect integument consists of three principal layers. What are they, from the outermost to the innermost?
(A) Cuticle, epidermis, basement membrane
(B) Basement membrane, epidermis, cuticle
(C) Epicuticle, procuticle, basement membrane
(D) Epidermis, exocuticle, endocuticle

2010

8. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The insect epicuticle is primarily responsible for preventing desiccation.
Reason (R): The epicuticle contains highly cross-linked sclerotin and chitin microfibrils.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

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2007

9. Chemically, chitin found in the insect procuticle is most accurately classified as a polymer of which molecule?
(A) Alpha-D-glucose
(B) N-acetyl-D-glucosamine
(C) N-acetyl-D-glucosamine
(D) D-glucuronic acid

2024

10. Consider the following statements regarding the sclerotization process in the insect integument:
I. It involves the cross-linking of cuticular proteins by quinones.
II. It predominantly occurs in the endocuticle layer after moulting.
III. It provides mechanical strength and rigidity to the exocuticle.
IV. It renders the affected cuticle highly water-soluble.
Which of the above statements are correct?
(A) I and II
(B) I and III
(C) II, III and IV
(D) I, II and IV

2006

11. What is the primary structural difference between the exocuticle and the endocuticle?
(A) The exocuticle contains metabolically active living cells, whereas the endocuticle is entirely non-cellular
(B) The exocuticle lacks chitinous microfibrils entirely, whereas the endocuticle is heavily chitinized
(C) The exocuticle is formed only after ecdysis, whereas the endocuticle is formed prior to ecdysis
(D) The exocuticle is sclerotized and pigmented, while the endocuticle is unsclerotized and flexible

2007

12. Which cuticular protein is characterized by its high elasticity, allowing energy storage in jumping insects like fleas and locusts?
(A) Resilin
(B) Arthropodin
(C) Sclerotin
(D) Fibroin

2002

13. Which of the following is NOT a primary function of the insect epidermis?
(A) Secretion of the cuticular layers
(B) Synthesis of circulating hemolymph proteins
(C) Production of moulting fluid
(D) Absorption of digestion products from the moulting fluid

2004

14. Arrange the following cellular and biochemical events of the moulting cycle in their correct chronological order:
I. Secretion of moulting fluid into the apolysial space
II. Epidermal cell enlargement and mitotic division
III. Digestion of the old endocuticle and absorption of products
IV. Secretion of the new epicuticle
(A) II, I, IV, III
(B) II, IV, I, III
(C) I, II, III, IV
(D) IV, I, II, III

2024

15. The specialized epidermal cells responsible for secreting the cement layer of the epicuticle are known as:
(A) Dermal gland cells
(B) Trichogen cells forming the shaft of a seta
(C) Tormogen cells forming the socket of a seta
(D) Oenocytes involved in lipid and pheromone synthesis

2013

16. What is the main compositional characteristic of the basement membrane in the insect integument?
(A) It consists of heavily sclerotized chitin microfibrils that provide structural support
(B) It is a complex lipid bilayer that functions as a sieve to filter hemolymph cells
(C) It is an amorphous layer composed of neutral mucopolysaccharides and collagen-like proteins
(D) It is a crystalline structure formed by the accumulation of uric acid deposits

NODIA

2001

17. During ecdysis, why does the moulting fluid not digest the newly formed underlying cuticle?
(A) The moulting fluid only contains proteolytic enzymes that act specifically on the old epicuticle
(B) The epidermal cells continuously neutralize the enzymes near the new cuticle
(C) The new cuticle is completely devoid of chitin microfibrils until after the ecdysis process is finished

(D) The new cuticle is protected by a newly secreted, enzyme-resistant epicuticle

2006

18. If a chemical inhibitor severely disrupted the integrity of the basement membrane, which physiological process would be most directly affected initially?
(A) Synthesis of the protective cement layer on the surface of the epicuticle
(B) Cross-linking of quinones in the exocuticle to facilitate sclerotization
(C) Nutrient and hormone exchange between the hemolymph and the epidermis
(D) Contraction of the flight muscles

2019

19. Morphologically, how does a true seta differ from a spine?
(A) A seta is a specialized multicellular outgrowth, while a spine is purely a unicellular extension
(B) A seta has an articulated base (alveolus), while a spine is a rigid, unarticulated outgrowth
(C) A seta consists exclusively of the epicuticle, while a spine contains all primary layers
(D) A seta is completely devoid of sensory innervation, whereas all spines are innervated

2008

20. Match the cuticular outgrowth in List-I with its structural description in List-II.
List-I: (Outgrowth)
P. Microtrichia
Q. Spur
R. Scale
S. Seta
List-II: (Description)
1. Flattened, modified macrotrichium often bearing structural colors
2. Articulated, multicellular outgrowth with sensory or clothing functions
3. Movable, articulated spine-like structure typically found on the tibia
4. Minute, non-articulated subcellular cuticular extensions
(A) P-4, Q-3, R-1, S-2
(B) P-3, Q-4, R-2, S-1
(C) P-1, Q-2, R-4, S-3
(D) P-4, Q-2, R-1, S-3

2004

21. Which term describes the fixed, non-articulated, minute hair-like projections that are formed without the involvement of specialized trichogen cells?
(A) Microtrichia
(B) Macrotrichia
(C) Setae
(D) Spurs

2025

22. Consider the following statements regarding tibial spurs:
I. They are articulated, multicellular outgrowths of the cuticle.
II. They are commonly used in taxonomic identification of insect orders.
III. They possess a basal membranous articulation allowing mobility.
Which of the above statements are correct?
(A) I and II
(B) I only
(C) II and III
(D) I, II and III

2025

23. In the formation of a sensory seta, which pair of cells is correctly matched with its specific developmental role?
(A) Trichogen cell – secretes the setal shaft; Tormogen cell – forms the setal membrane/ socket
(B) Trichogen cell – forms the socket; Tormogen cell – secretes the chitinous setal shaft
(C) Oenocyte – forms the sensory nerve; Trichogen cell – secretes the structural socket
(D) Tormogen cell – forms the sensory nerve; Dermal gland – secretes the setal shaft

2006

24. Which cuticular modification is primarily responsible for the structural coloration observed in the wings of Morpho butterflies?
(A) Thickened and heavily sclerotized cuticular spines
(B) Dense patches of non-articulated microtrichia
(C) Pigment-filled dermal glands located in the epidermis
(D) Microscopic ridges on flattened scales

2003

25. Internal ridges or growths of the insect body wall that serve as sites for muscle attachment are collectively termed:
(A) Sulci
(B) Apodemes
(C) Sclerites

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(D) Phragmata

2003

26. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The cranial tentorium acts as an internal brace for the insect head capsule.
Reason (R): The tentorium is formed by the invagination of the cuticular wall at the anterior and posterior tentorial pits.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2023

27. When an internal apodeme takes the form of a distinct peg-like or finger-like projection, it is specifically referred to as a(n):
(A) Sulcus
(B) Costa
(C) Suture
(D) Apophysis

2019

28. Which of the following components is NOT typically part of the insect cranial tentorium?
(A) Ventral nerve cord
(B) Anterior arms
(C) Posterior arms
(D) Corporotentorium (tentorial bridge)

2003

29. In the pterothorax of flying insects, large plate-like apodemes that extend inward from the terga to support massive flight muscles are called:
(A) Furcae
(B) Phragmata
(C) Apophyses
(D) Tentoria

2019

30. If a mutation caused an insect to lack the anterior arms of its tentorium, what functional impairment would be most directly observed?
(A) Complete failure of the biochemical processes during moulting
(B) Inability to effectively utilize mandibular muscles for chewing
(C) Inability to effectively articulate the wings during flight
(D) Loss of sensory reception in the posterior abdominal cerci

2004

31. What characterizes secondary segmentation as opposed to primary segmentation in insects?
(A) It shifts the functional segment boundary to include the sclerotized region behind the primary fold
(B) It occurs only during the late embryonic stage, while primary segmentation happens in adults
(C) It lacks flexible intersegmental membranes entirely, making the body wall rigid
(D) It is solely determined by the anatomical position of the respiratory spiracles

2015

32. Consider the following statements concerning insect body segmentation:
I. Primary segmentation is typical of soft-bodied insect larvae.
II. Secondary segmentation is characteristic of sclerotized adult insects.
III. In secondary segmentation, longitudinal muscles attach to the antecostae.
IV. The visible intersegmental membrane in secondary segmentation is formed from the posterior part of the preceding primary segment.
V. Secondary segmentation severely restricts all body movement.
Which of the above statements are correct?
(A) I, II, III and IV
(B) I, III, IV and V
(C) II, III, IV and V
(D) I, II, IV and V

2019

33. The flexible, unsclerotized areas of the integument that connect adjacent sclerites and allow for body movement are called:
(A) Internal cuticular apodemes
(B) External anatomical sutures
(C) Anterior tentorial pits
(D) Intersegmental membranes

2005

34. Which statement about the attachment of longitudinal body muscles in adult insects is INCORRECT?
(A) They attach to the antecostal ridges
(B) They span across the functional intersegmental membranes
(C) They attach directly to the flexible intersegmental membranes
(D) Their contraction draws adjacent sclerotized segments closer together

NODIA

2003

35. A caterpillar primarily exhibits which type of segmentation, allowing it to move via peristaltic waves?
(A) Rigid secondary segmentation
(B) Primary segmentation
(C) Appendicular segmentation
(D) Tagmosis-independent segmentation

2009

36. The narrow, hardened anterior margin of a secondary segment, separated from the rest of the tergum by the antecostal sulcus, is the:
(A) Pleuron
(B) Postnotum
(C) Sternellum
(D) Acrotergite

2017

37. The typical insect body segment is box-like, composed of four principal sclerotized regions. What are the lateral regions called?
(A) Pleura
(B) Terga
(C) Sterna
(D) Nota

2021

38. Match the sclerotized regions in List-I with their anatomical positions on an insect segment in List-II.
List-I: (Sclerite)
P. Tergum
Q. Sternum
R. Pleuron
S. Notum
List-II: (Anatomical Position)
1. Ventral region
2. Dorsal region of any body segment
3. Lateral region
4. Dorsal region specifically of a thoracic segment
(A) P-2, Q-1, R-3, S-4
(B) P-4, Q-2, R-1, S-3
(C) P-1, Q-3, R-2, S-4
(D) P-2, Q-4, R-1, S-3

2019

39. In modern insect morphology, a functional groove marking the external invagination of the cuticle to form an apodeme is formally termed a:
(A) Sulcus
(B) Suture
(C) Fissure
(D) Linea

2015

40. The pleural sulcus divides the thoracic pleuron into two major sclerites. What are they?
(A) Prescutum and scutum
(B) Basisternum and sternellum
(C) Acrotergite and postnotum
(D) Episternum and epimeron

2010

41. Consider the following statements regarding anatomical lines and grooves in insects:
I. A true sulcus is an external groove marking an internal ridge.
II. A true suture is a line of fusion between two formerly separate sclerites.
III. The ecdysial line is heavily sclerotized to prevent premature rupturing.
IV. Sulci provide structural reinforcement to the exoskeleton.
Which of the above statements are correct?
(A) I, II and IV
(B) I and III
(C) III only
(D) II, III and IV

2021

42. What is a primary mechanical consequence of extensive sclerotization in adult insects?
(A) Significant increase in the permeability of the cuticle to water and gases
(B) Ability to achieve rapid expansion of body size without the need for moulting
(C) Loss of continuous body flexibility, requiring joints with membranes
(D) Elimination of the need for internal apodemes

2012

43. Which of the following is considered the least relevant function of the unsclerotized intersegmental membranes?
(A) Facilitating abdominal expansion during feeding or egg development
(B) Providing necessary articulation points for the movement of legs and wings
(C) Allowing the extensive telescoping of abdominal segments during movement
(D) Serving as the primary attachment sites for large striated muscles

2007

44. An insect head orientation in which the mouthparts are directed downwards, perpendicular to the longitudinal axis of the body, is termed:
(A) Hypognathous
(B) Prognathous

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(C) Opisthognathous
(D) Entognathous

2017

45. Select the correct sequence matching the head orientation descriptions: Mouthparts ventral → Mouthparts anterior → Mouthparts posteroventral.
(A) Prognathous → Hypognathous → Opisthognathous
(B) Hypognathous → Prognathous → Opisthognathous
(C) Opisthognathous → Prognathous → Hypognathous
(D) Hypognathous → Opisthognathous → Prognathous

2015

46. Which insect order is classically cited as having a prognathous head orientation due to its predatory larval or adult habits?
(A) Orthoptera
(B) Coleoptera
(C) Hemiptera
(D) Diptera

2011

47. The opisthognathous head orientation is an adaptation primarily found in which of the following groups?
(A) Plant-sap sucking true bugs (Hemiptera)
(B) Predatory ground beetles searching for prey
(C) Leaf-chewing caterpillars in the larval stage
(D) Pollen-collecting bees visiting floral sources

2018

48. Identify the correctly paired head orientation and representative insect group:
(A) Prognathous – Grasshoppers
(B) Opisthognathous – Tiger beetles
(C) Hypognathous – Cockroaches
(D) Hypognathous – Cicadas

2011

49. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Predatory insects like carabid beetles typically possess a prognathous head orientation.
Reason (R): A prognathous head directs the mandibles forward, aiding in the active pursuit and capturing of prey.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

NODIA

2022

50. In an opisthognathous insect, the beak-like mouthparts appear to arise from:
(A) The vertex of the head capsule
(B) The anterior extremity of the head
(C) Between the bases of the forelegs
(D) The occipital foramen

2009

51. The topmost part of the insect cranial capsule, located between the compound eyes, is designated as the:
(A) Gena
(B) Vertex
(C) Clypeus
(D) Occiput

2005

52. The prominent facial area of the insect head, situated anteriorly below the vertex and bordered laterally by the frontal sulci, is the:
(A) Submentum
(B) Occiput
(C) Gena
(D) Frons

2025

53. Match the specific areas of the cranial capsule in List-I with their relative positions in List-II.
List-I: (Cranial Area)
P. Gena
Q. Clypeus
R. Occiput
S. Postgena
List-II: (Relative Position)
1. Posterior surface behind the vertex and eyes
2. Lateral area below the compound eyes (cheeks)
3. Anterior area just above the labrum
4. Lateral area posterior to the gena
(A) P-2, Q-3, R-1, S-4
(B) P-3, Q-2, R-4, S-1
(C) P-1, Q-4, R-2, S-3
(D) P-2, Q-1, R-4, S-3

2016

54. The clypeus articulates directly with which mouthpart structure at its ventral margin?
(A) Mandible
(B) Maxilla
(C) Labrum
(D) Labium

2013

55. The submentum is a basal structural component associated with which part of the insect head system?
(A) The labium
(B) The primary cranial capsule
(C) The maxillary appendages
(D) The hypopharynx

2022

56. Consider the following statements concerning the sulci of the insect head:
I. The epistomal sulcus separates the frons from the clypeus.
II. The subgenal sulcus lies above the bases of the mandibles and maxillae.
III. The circumocular sulcus reinforces the head wall around the compound eye.
Which of the above statements are correct?
(A) I and II
(B) I only
(C) II and III
(D) I, II and III

2004

57. The basal segment of the typical insect antenna, which articulates directly with the head capsule, is the:
(A) Pedicel
(B) Scape
(C) Flagellum
(D) Clavola

2013

58. Johnston's organ is a specialized mechanoreceptor found universally in which segment of the adult insect antenna?
(A) Scape
(B) First flagellomere
(C) Pedicel
(D) Terminal flagellomere

2013

59. What is the primary physiological function of Johnston's organ in male mosquitoes?
(A) Chemoreception of volatile female pheromones
(B) Detection of flight speed through air currents
(C) Measurement of the surrounding ambient temperature
(D) Auditory reception of female wingbeat frequencies

2007

60. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): In all true insects (Ectognatha), the flagellum of the antenna lacks intrinsic muscles.
Reason (R): Movement of the flagellum is mediated by muscles originating in the scape and inserting on the base of the pedicel.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2011

61. Which of the following groups possesses musculature within the individual segments of the antennal flagellum?
(A) Orthoptera
(B) Collembola
(C) Hemiptera
(D) Lepidoptera

2016

62. Which of the following statements about the structure of a basic insect antenna is INCORRECT?
(A) The antennal socket is often surrounded by a reinforcing, sclerotized antennal sclerite
(B) The flagellum is typically composed of multiple true segments, each with independent musculature
(C) A small pivot process called the antennifer allows the scape to articulate with the head
(D) The flagellum is the region primarily responsible for bearing various olfactory sensilla

2024

63. How does a capitate antenna differ morphologically from a clavate antenna?
(A) A capitate antenna has an abrupt terminal knob, while a clavate antenna swells gradually
(B) A capitate antenna is thread-like, while a clavate antenna is saw-toothed
(C) A capitate antenna has a gradual terminal swelling, while a clavate antenna has an abrupt knob
(D) A capitate antenna possesses a large bristle called an arista, which a clavate antenna lacks

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2023

64. Match the antennal types in List-I with the representative insect taxa in List-II.
List-I: (Antennal Type)
P. Plumose
Q. Geniculate
R. Aristate
S. Lamellate
List-II: (Taxa)
1. Scarab beetles
2. House flies (Muscidae)
3. Male mosquitoes
4. Ants and chalcid wasps
(A) P-1, Q-4, R-2, S-3
(B) P-3, Q-4, R-2, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-3, R-1, S-4

2006

65. The distinct bristle-like structure extending from the enlarged third segment of a house fly's antenna is called the:
(A) Stylus
(B) Clava
(C) Funiculus
(D) Arista

2021

66. Consider the following statements regarding specialized antennal shapes:
I. Filiform antennae are long and thread-like, common in ground beetles.
II. Moniliform antennae resemble a string of beads, found in termites.
III. Pectinate antennae have comb-like lateral processes, typical of female mosquitoes.
IV. Serrate antennae are saw-toothed, observed in click beetles.
V. Setaceous antennae taper to a point, characteristic of dragonflies.
Which of the above statements is INCORRECT?
(A) I, II and IV
(B) II, IV and V
(C) III only
(D) I, III and V

2024

67. The feathery structure of a plumose antenna is an evolutionary adaptation that primarily serves to:
(A) Provide a protective surface to deflect water during heavy rainfall
(B) Maximize surface area for detecting airborne chemical signals or sounds
(C) Act as a physical tracheal gill to facilitate aquatic respiration
(D) Provide aerodynamic stability and lift during complex flight

2017

68. Which type of antenna features an abrupt bend resembling a knee joint, typically between the long scape and the rest of the antenna?
(A) Moniliform
(B) Aristate
(C) Pectinate
(D) Geniculate

2005

69. Which type of mouthparts is considered the most primitive and generalized in insects?
(A) Biting and chewing
(B) Piercing and sucking
(C) Siphoning nectar
(D) Sponging liquids

2022

70. In biting and chewing mouthparts, the heavily sclerotized, unsegmented jaws used primarily for cutting and crushing food are the:
(A) Maxillae
(B) Labial palps
(C) Mandibles
(D) Galeae

2010

71. Arrange the parts of a generalized maxilla in correct anatomical order from the basal articulation with the head to the distal tips:
I. Stipes
II. Cardo
III. Lacinia and Galea
(A) I, II, III
(B) III, I, II
(C) II, I, III
(D) I, III, II

NODIA

2025

72. The labium of an insect represents the evolutionary fusion of:
(A) The first pair of maxillae and the mandibles
(B) The labrum and the hypopharynx
(C) The pedipalps
(D) The second pair of maxillae

2022

73. In the preoral cavity of chewing insects, the central tongue-like lobe that bears the opening of the salivary ducts is the:
(A) Epipharynx
(B) Hypopharynx

(C) Glossa
(D) Paraglossa

2014

74. Consider the following statements concerning the labrum:
I. It functions as the upper lip covering the mandibles.
II. It is a pair of fused appendages homologous to the maxillae.
III. Its inner surface is often modified into a swollen epipharynx.
IV. It contains the primary taste receptors in biting insects.
Which of the above statements are correct?
(A) I and II
(B) I and III
(C) II, III and IV
(D) I, III and IV

2017

75. In the piercing-sucking mouthparts of a typical mosquito, the stylets are enclosed in a protective sheath formed by the:
(A) Labrum
(B) Maxillae
(C) Mandibles
(D) Labium

2019

76. What is the primary difference in the liquid-feeding mechanism between sponging (e.g., house fly) and chewing-lapping (e.g., honey bee) mouthparts?
(A) Sponging mouthparts utilize pseudotracheae to soak up liquids, whereas chewing-lapping mouthparts utilize a hairy glossa to lap nectar
(B) Sponging mouthparts rely on capillary action in a tube, while chewing-lapping ones pierce tissues
(C) Sponging mouthparts utilize functioning mandibles, while chewing-lapping ones lack mandibles entirely
(D) Sponging mouthparts lack maxillary palps, while chewing-lapping ones have prominent maxillary palps

2001

77. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): In adult Lepidoptera, the siphoning proboscis is formed by the highly elongated mandibles.
Reason (R): The proboscis coils up under the head due to the elasticity of its cuticle when muscles relax.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019

78. Pseudotracheae are specialized capillary channels found on the labellum of which type of modified mouthparts?
(A) Siphoning
(B) Sponging
(C) Chewing-lapping
(D) Piercing-sucking

2007

79. In the chewing-lapping mouthparts of honey bees, the temporary food canal used for sucking nectar is formed by the juxtaposition of the:
(A) Galeae and labial palps tightly surrounding the glossa
(B) Labrum and mandibles working in conjunction with the epipharynx
(C) Hypopharynx and labium combined with the maxillary structures
(D) Maxillary palps and paraglossae forming a temporary suction tube

2007

80. The piercing-sucking mouthparts of Hemiptera (true bugs) differ from those of mosquitoes mainly in that Hemiptera:
(A) Utilize the labrum to form the stylet sheath
(B) Have well-developed, biting mandibles for chewing
(C) Completely lack maxillary palps and labial palps
(D) Do not possess a distinct salivary canal

2025

81. The term "pterothorax" refers specifically to which segments of the insect body?
(A) Prothorax and mesothorax combined
(B) Prothorax, mesothorax, and metathorax collectively
(C) The metathorax and the first abdominal segment
(D) Mesothorax and metathorax combined

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2019

82. In heavily flight-adapted insects like Diptera and Hymenoptera, which thoracic segment is typically the smallest and least sclerotized?
(A) Mesothorax
(B) Metathorax
(C) Prothorax
(D) Pterothorax

2015

83. Consider the following features associated with the pterothorax:
I. It bears the articulating wings.
II. Its tergum is divided into a scutum and scutellum.
III. It lacks internal phragmata completely.
Which of the above features are correct?
(A) I and II
(B) I only
(C) II and III
(D) I and III

2008

84. Which structure provides the primary support and articulation point for the wing on the thoracic pleuron?
(A) Epimeron
(B) Episternum
(C) Pleural wing process
(D) Basalar sclerite

2017

85. Which statement about the thoracic spiracles in adult insects is INCORRECT?
(A) The spiracles are usually located directly on the heavily sclerotized nota
(B) There are typically two pairs of thoracic spiracles
(C) They are situated in the pleural regions, often between the segments
(D) They serve as the primary entry points for oxygen into the tracheal system

2005

86. The internal, Y-shaped sternal apophyses in the pterothorax that support ventral muscles are termed:
(A) Tentoria
(B) Phragmata
(C) Furcae
(D) Costae

2014

87. The basal-most segment of a typical insect leg, which articulates with the thoracic pleuron, is the:
(A) Coxa
(B) Trochanter
(C) Femur
(D) Tibia

2022

88. Select the sequence that correctly lists the segments of a generalized insect leg from proximal to distal.
(A) Coxa → Trochanter → Femur → Tibia → Tarsus → Pretarsus
(B) Trochanter → Coxa → Femur → Tibia → Tarsus → Pretarsus
(C) Coxa → Femur → Trochanter → Tibia → Pretarsus → Tarsus
(D) Coxa → Trochanter → Tibia → Femur → Tarsus → Pretarsus

2008

89. The paired claws (ungues) at the terminal end of an insect leg are structures belonging to the:
(A) Tarsus
(B) Pretarsus
(C) Tibia
(D) Trochantin

2009

90. What is the structural difference between an arolium and an empodium?
(A) An arolium is a specialized adhesive structure found on the tibia, while an empodium is on the tarsus
(B) An arolium primarily aids in digging and excavation, while an empodium is specifically for jumping
(C) An arolium is a median pad between claws, while an empodium is a spine-like or pad-like structure
(D) An arolium is a lateral sensory hair, while an empodium is the primary claw

2001

91. The small, paired, pad-like structures located beneath the base of each claw, commonly seen in house flies for adhesion, are the:
(A) Empodia
(B) Arolia
(C) Crochets
(D) Pulvilli

2010

92. In most insects, the trochanter acts functionally as a joint segment. It is typically articulated immovably with which adjacent segment?
(A) Femur
(B) Coxa

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(C) Tibia
(D) Tarsus

2023

93. Grasshoppers (Orthoptera) are well-known for their enlarged hind legs adapted for jumping. This functional modification is termed:
(A) Cursorial
(B) Saltatorial
(C) Fossorial
(D) Raptorial

2022

94. The forelegs of a mole cricket are heavily sclerotized, flattened, and equipped with strong teeth. This leg type is adapted for digging and is known as:
(A) Raptorial
(B) Fossorial
(C) Natatorial
(D) Cursorial

2012

95. Consider the following list of leg modifications and their corresponding functions or insect examples:
I. Raptorial – Grasping prey (e.g., Praying mantis)
II. Natatorial – Swimming (e.g., Water boatmen)
III. Corbiculate – Pollen collecting (e.g., Honey bees)
IV. Cursorial – Running (e.g., Cockroaches)
V. Fossorial – Jumping (e.g., Fleas)
Which of the above combinations are correct?
(A) I, II, III and V
(B) I, II, III and IV
(C) II, III, IV and V
(D) I, III, IV and V

2005

96. A predatory insect with forelegs featuring a highly elongated coxa, and a femur and tibia armed with interlocking spines, most likely possesses which leg type?
(A) Fossorial
(B) Saltatorial
(C) Raptorial
(D) Scansorial

2024

97. The pollen basket (corbicula) of a worker honey bee is specifically located on the outer surface of which segment of the hind leg?
(A) Femur
(B) First tarsomere (basitarsus)
(C) Coxa
(D) Tibia

2025

98. Natatorial legs, adapted for swimming in aquatic beetles, generally feature which morphological modification?
(A) Enlarged, muscular coxae for propulsion
(B) Sharp terminal hooks to grip water tension
(C) Dense rows of long, stiff setae serving as oars
(D) Fused tarsal segments forming a solid paddle

2003

99. Which of the following insects does NOT represent a cursorial leg modification?
(A) Tiger beetle
(B) Praying mantis
(C) Cockroach
(D) Ground beetle

2019

100. The anterior margin of an insect wing, which cuts through the air during flight, is known as the:
(A) Anal margin
(B) Apical margin
(C) Jugal margin
(D) Costal margin

2025

101. The distinct corner of the wing where the costal margin meets the apical margin is referred to as the:
(A) Apical angle
(B) Humeral angle
(C) Anal angle
(D) Axillary angle

2005

102. Small, sclerotized plates situated in the membranous base of the wing that articulate with the thoracic nota and wing veins are the:
(A) Internal thoracic phragmata
(B) Specialized basal tegulae
(C) Axillary sclerites
(D) Posterior wing jugal lobes

2024

103. Which basal plate is primarily associated with the prominent fold that divides the remigium from the vannal region during wing folding?
(A) Median plate
(B) First axillary sclerite
(C) Tegula
(D) Humeral plate

NODIA

2023

104. The small proximal lobe at the posterobasal base of the forewing, separated from the vannal area by the jugal fold, is the:
(A) Alula
(B) Calypter
(C) Pterostigma
(D) Jugal lobe

2006

105. Which statement concerning wing articulation in Neoptera is INCORRECT?
(A) Axillary sclerites facilitate wing folding over the abdomen
(B) Neopteran insects lack pleural wing processes entirely
(C) The first axillary articulates with the anterior notal wing process
(D) Muscles attached to the third axillary sclerite pivot the wing backward

2015

106. The standard system used universally by entomologists to designate the longitudinal veins and branches of insect wings is the:
(A) Snodgrass-Weber system
(B) Wigglesworth-Chapman system
(C) Comstock-Needham system
(D) Kukalová-Peck system

2001

107. According to the generalized wing venation model, which vein typically runs along or just behind the anterior leading edge of the wing?
(A) Subcosta (Sc)
(B) Radius (R)
(C) Media (M)
(D) Costa (C)

2022

108. In the primitive wing venation plan, the Radius (R) vein typically divides into how many primary branches reaching the wing margin?
(A) Two
(B) Three
(C) Five
(D) Seven

2006

109. Short transverse veins that connect adjacent longitudinal veins to reinforce the wing membrane are called:
(A) Intercalary veins
(B) Cross veins
(C) Axillary cords
(D) Radial sectors

2005

110. Which statement INCORRECTLY applies to the generalized Comstock-Needham venation system?
(A) The Cubitus (Cu) typically branches into Cu1 and Cu2
(B) The Subcosta (Sc) never reaches the wing margin
(C) The Anal veins (A) are usually unbranched
(D) The Media (M) divides into anterior (MA) and posterior (MP) branches

2011

111. The longitudinal veins occupying the posterior (vannal) region of the wing, usually fanning out from the third axillary sclerite, are the:
(A) Anal veins
(B) Cubital veins
(C) Medial veins
(D) Jugal veins

2009

112. A wing coupling mechanism where a small lobe at the base of the forewing overlaps the anterior margin of the hindwing, characteristic of primitive moths, is called:
(A) Hamulate
(B) Frenate
(C) Jugate
(D) Amplexiform

2006

113. In the frenate coupling mechanism common in higher Lepidoptera, what is the role of the frenulum?
(A) It is a specialized hook on the forewing that grasps a corresponding fold on the hindwing
(B) It is a glandular structure that secretes an adhesive substance to temporarily bond wings
(C) It is an enlarged jugal lobe that hooks into the scutellum
(D) A stout bristle or cluster on the hindwing that locks into a forewing retinaculum

2022

114. Which wing coupling mechanism relies on extensive overlapping of the broad forewing and hindwing margins without any specialized hooks or bristles, as seen in true butterflies (Papilionoidea)?
(A) Frenate
(B) Hamulate
(C) Amplexiform
(D) Jugate

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2002

115. Bees and wasps (Hymenoptera) lock their fore and hind wings together during flight using a row of tiny hooks on the costal margin of the hindwing. This is termed:
(A) Frenate coupling
(B) Hamulate coupling
(C) Jugate coupling
(D) Retinacular coupling

2013

116. If an advanced moth genetically lost its retinaculum, what would be the functional consequence?
(A) The jugum would automatically enlarge to compensate for the missing locking mechanism
(B) The wings would permanently lock together, preventing landing
(C) The halteres would take over the essential function of balancing the moth during flight
(D) The frenulum would have nothing to anchor to, disrupting synchronized flight

2005

117. In sexual dimorphism of frenate Lepidoptera, how does the retinaculum typically differ between males and females?
(A) Males have a subcostal hook, while females have a cubital tuft of scales
(B) Males lack a retinaculum completely while females possess a complex subcostal fold
(C) Males have a specialized jugum instead of a retinaculum to couple their wing surfaces
(D) Females have a heavily sclerotized hook, while males use amplexiform coupling

2012

118. Which concept best explains the evolutionary advantage of functional wing coupling mechanisms in Neopteran insects?
(A) It allows insects to shed their wings instantly when attacked by a potential predator
(B) It creates the specific turbulent drag required for hovering in confined environments
(C) It converts independent wings into a single surface, increasing flight efficiency
(D) It prevents the wings from folding over the abdomen when at rest

2017

119. The thickened, heavily sclerotized forewings of beetles (Coleoptera) that protect the membranous hindwings and abdomen are called:
(A) Elytra
(B) Hemelytra
(C) Tegmina
(D) Halteres

2022

120. Which pair correctly matches the modified wing type with its distinguishing characteristic?
(A) Tegmina – Thickened, veinless forewings of beetles
(B) Elytra – Leathery, parchment-like forewings of grasshoppers
(C) Halteres – Large, broad hindwings of butterflies
(D) Hemelytra – Basal half thickened and corium-like, apical half membranous

2007

121. The leathery, parchment-like forewings typical of Orthoptera (grasshoppers) and Dictyoptera (cockroaches) are termed:
(A) Elytra
(B) Tegmina
(C) Hemelytra
(D) Pseudo-wings

2003

122. In the order Diptera, the hindwings are highly reduced into small, knob-like structures that function as gyroscopic balancing organs. These are called:
(A) Alulae
(B) Calypters
(C) Halteres
(D) Tegulae

2001

123. Consider the following statements concerning wing modifications:
I. In Thysanoptera (thrips), the wings are fringed with long setae and lack a central membranous blade entirely.
II. In Strepsiptera, the forewings are reduced to haltere-like structures while hindwings are broad.
III. In Lepidoptera, wings are covered in overlapping, flattened macrotrichia (scales).
IV. In Hemiptera, the hemelytra function primarily as primary flight propulsion surfaces.
Which of the above statements is INCORRECT?
(A) I, II and III
(B) II, III and IV
(C) IV only
(D) I, III and IV

NODIA

2014

124. The scales covering the wings of moths and butterflies are technically modified:
(A) Setae (macrotrichia)
(B) Microtrichia
(C) Spines
(D) Spurs

2015

125. The primitive, generalized insect abdomen is considered to consist of how many true metameres?
(A) 8
(B) 11
(C) 14
(D) 15

2022

126. The pregenital segments of the adult insect abdomen typically lack visible appendages. Which segments generally constitute the pregenital region?
(A) Segments 1 to 5
(B) Segments 8 and 9
(C) Segments 10 and 11
(D) Segments 1 to 7

2019

127. In female insects, the functional genital segments that bear the appendicular ovipositor are typically:
(A) Segments 8 and 9
(B) Segments 7 and 8
(C) Segments 9 and 10
(D) Segments 10 and 11

2019

128. Which of the following is NOT a feature of the postgenital abdominal segments in a typical adult insect?
(A) Presence of the anus at the posterior extremity
(B) Bearing the cerci on the 11th segment
(C) Presence of functional spiracles on the 11th segment
(D) Formation of the epiproct and paraprocts

2009

129. Abdominal spiracles, used for respiration, are generally located on which part of the abdominal segments?
(A) The dorsal center of the terga
(B) The ventral sterna
(C) The posterior margin of the intersegmental membranes
(D) The lateral pleural membranes

2003

130. The evolutionary trend in higher insects regarding the abdomen is characterized by:
(A) An increase in the total number of metameres to fifteen or more
(B) The redevelopment of jointed walking legs on pregenital segments
(C) A reduction in the visible number of segments through fusion or telescoping
(D) The heavy sclerotization of pleural membranes to form a solid ring

2010

131. The ventral tube-like structure on the first abdominal segment of Collembola, involved in osmoregulation and adhesion, is the:
(A) Furcula
(B) Collophore
(C) Tenaculum
(D) Stylus

2006

132. In springtails (Collembola), the forked jumping organ located on the fourth abdominal segment is known as the:
(A) Epiproct
(B) Tenaculum
(C) Cercus
(D) Furcula

2003

133. The tenaculum in Collembola functions primarily to:
(A) Hold the furcula under tension against the ventral abdomen
(B) Secrete an adhesive mucus for sticking to smooth surfaces
(C) Detect environmental vibrations and tactile stimuli
(D) Aid in the mechanical transfer of sperm during copulation

2008

134. Primitive wingless insects like Archaeognatha possess paired, unjointed, peg-like appendages on their pregenital abdominal sterna known as:
(A) Prolegs
(B) Crochets
(C) Styli
(D) Cerci

2006

135. The abdominal appendages in Protura are unique among hexapods because:
(A) They retain small, limb-like appendages on the first three segments

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(B) They possess fully functional wings on the first abdominal segment
(C) They have modified their cerci into venomous, protective stingers
(D) They use a specialized furcula to perform extreme leaping escapes

2024

136. Which of the following statements INCORRECTLY compares the abdominal appendages of Apterygota and Pterygota?
(A) Apterygotes retain many pregenital appendages, whereas adult Pterygotes largely lack them
(B) Both groups possess cerci on the 11th segment (when present)
(C) Apterygote appendages like the collophore are homologous to the pterygote wings
(D) Styli in Apterygota are considered rudimentary abdominal legs

2017

137. The presence of abdominal styli in Apterygota is evolutionarily significant because it supports the theory that:
(A) Insects evolved directly from ancestors with fixed wings
(B) Insect ancestors possessed articulated appendages on all body segments
(C) The insect abdomen was originally devoid of any appendages
(D) Apterygotes are actually specialized crustaceans, not hexapods

2008

138. The unjointed, fleshy abdominal legs found on the pregenital segments of lepidopteran larvae (caterpillars) are called:
(A) Styli
(B) Cerci
(C) Prolegs
(D) Furcae

2011

139. To assist in gripping plant surfaces, the distal ends (plantae) of lepidopteran prolegs are equipped with tiny sclerotized hooks known as:
(A) Ungues
(B) Calcars
(C) Spines
(D) Crochets

2012

140. In the aquatic nymphs of Ephemeroptera, lateral abdominal appendages modified for respiration are referred to as:
(A) Tracheal gills
(B) Air tubes
(C) Siphons
(D) Plastrons

2008

141. Cerci are paired sensory appendages typically arising from the 11th abdominal segment. In which insect order are they characteristically modified into unsegmented, heavily sclerotized forceps?
(A) Ephemeroptera
(B) Dermaptera
(C) Plecoptera
(D) Orthoptera

2001

142. Identify the correctly paired structure and its corresponding description in Pterygota:
(A) Prolegs – Fleshy, unjointed abdominal appendages found in larval stages
(B) Median caudal filament – A long thread-like extension of the epiproct in silverfish and mayflies
(C) Styli – Sensory organs found on the thoracic segments of caterpillars
(D) Crochets – Respiratory gills found on the terminal segment of dragonfly naiads

2014

143. The terminal pair of prolegs on the last abdominal segment of a caterpillar is specifically referred to as:
(A) Anal prolegs (claspers)
(B) Caudal cerci located at the end of the abdomen
(C) Pygidial hooks used for terrestrial locomotion
(D) Terminal styli found on primitive insect groups

2018

144. In highly specialized adult insects such as true bugs and flies, the cerci are often lost or greatly reduced. This is primarily correlated with:
(A) The development of an opisthognathous head orientation
(B) The evolution of specialized aquatic larval life stages
(C) The reduction or telescoping of the terminal abdominal segments
(D) The shifting of primary flight power to the hindwings

NODIA

2014

145. The true appendicular ovipositor in female insects is formed from specialized structures arising from which segments?
(A) 7th and 8th
(B) 8th and 9th
(C) 9th and 10th
(D) 10th and 11th

2003

146. Morphologically, the valvulae comprising the shaft of the ovipositor are considered homologous to which parts of a primitive segmental appendage?
(A) Basal segment coxae
(B) Articulated trochanters
(C) Endites (or gonapophyses)
(D) Respiratory epipodites

2014

147. In the generalized insect ovipositor, the basal sclerites that support the valvulae and act as pivot points are the:
(A) Gonopores
(B) Valvifers
(C) Spermathecae
(D) Paraprocts

2019

148. How does a "substitute ovipositor" (found in many Diptera and Lepidoptera) differ from a true appendicular ovipositor?
(A) It is formed by the fusion of the posterior cerci rather than appendicular valvulae
(B) It utilizes the hind legs to guide eggs into the substrate
(C) It is located on the seventh abdominal segment instead of the eighth and ninth
(D) It consists of extensible, telescopic terminal abdominal segments rather than distinct valves

2013

149. Identify the correct statement regarding the evolutionary modification of the ovipositor in stinging wasps and bees:
(A) The appendicular ovipositor is modified into a venom-injecting sting and no longer transmits eggs
(B) The ovipositor is entirely lost, and the sting is formed from the sensory cerci
(C) The substitute ovipositor telescopes outward to inject venom into the victim
(D) The valvulae form the venom gland, while the valvifers form the sting shaft

2016

150. Female fruit flies (Tephritidae) possess an elongated, tube-like structure at the end of their abdomen used to lay eggs inside fruit. This structure is a classic example of a:
(A) True appendicular ovipositor
(B) Modified 11th segment cerci
(C) Substitute ovipositor
(D) Furcula

2025

151. Comparing the appendicular ovipositor of a grasshopper with that of a cicada, what functional difference is typical?
(A) Grasshoppers use stout valves to dig; cicadas use saw-like valves to cut plant tissue
(B) The grasshopper has a substitute ovipositor while the cicada has a true appendicular one
(C) The grasshopper ovipositor is formed from the 10th segment, and the cicada's from the 8th
(D) The grasshopper uses its ovipositor for stinging; the cicada for digging

2005

152. Which of the following statements about female genital structures is INCORRECT?
(A) The opening of the common oviduct to the exterior is termed the gonopore
(B) The spermatheca functions specifically to store sperm after mating
(C) Accessory glands often secrete adhesives to attach eggs to substrates
(D) The ootheca in cockroaches is formed by the valvulae without secretion

2021

153. The primary intromittent organ of male insects, used to transfer sperm into the female reproductive tract, is the:
(A) Epiproct
(B) Aedeagus
(C) Cercus
(D) Valvifer

2002

154. In the generalized male insect genitalia, the paired, lateral clasping structures that grip the female during copulation are termed:
(A) Phallomeres
(B) Gonopores
(C) Parameres
(D) Endophalli

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2019

155. Identify the correct functional relationship in male genitalia:
(A) The ejaculatory duct forms the external sclerotized plates
(B) The aedeagus secretes the spermatophore casing
(C) The parameres produce seminal fluid
(D) Claspers maintain mechanical connection during copulation

2007

156. Why are the fine structural details of male external genitalia frequently used by taxonomists in species-level identification?
(A) They often exhibit highly complex, species-specific morphology due to rapid sexual selection
(B) They are the largest and most easily visible structures on the insect's external body
(C) They remain completely unsclerotized and flexible
(D) They are identical across all orders but differ randomly within specific families

2008

157. The primary male genital structures are almost exclusively associated with which abdominal segment?
(A) 7th segment
(B) 9th segment
(C) 10th segment
(D) 11th segment

2007

158. The eversible, internal membranous sac of the aedeagus that often bears spines or hooks to anchor within the female tract is called the:
(A) Phallobase
(B) Endophallus
(C) Tegmen
(D) Paramere

2018

159. Contrast the typical number of segments directly involved in the primary external genitalia between male and female insects:
(A) Males utilize one primary segment (9th), while females utilize two (8th and 9th)
(B) Males utilize two segments (9th and 10th), while females utilize one (8th)
(C) Males and females both utilize only the 8th segment
(D) Males utilize the 10th segment exclusively, while females use the 11th

NODIA

2024

160. The high structural specificity between complex male parameres/aedeagus and corresponding female genital plates in some insect groups is classically referred to as the:
(A) Stabilizing selection theory
(B) Secondary segmentation principle
(C) Lock-and-key hypothesis
(D) Genital homodynamy model

****

ANSWERS

1. (D) The grouping of adjacent body segments into functional morphological units
Tagmosis represents the evolutionary process where consecutive segments of an arthropod body are grouped together into distinct functional units. This morphological specialization allows different regions to perform specific biological roles, such as sensory perception, locomotion, or digestion. It involves the integration of segments and their associated appendages into integrated complexes that define the organism's body plan.

2. (C) Head, thorax, and abdomen
In the class Insecta, tagmosis has resulted in the body being organized into three primary regions which are the head, thorax, and abdomen. The head serves as the center for sensory input and feeding, while the thorax is specialized for locomotion. The abdomen contains the majority of visceral organs and is primarily responsible for reproduction and metabolic processes.

3. (C) Six
During the embryonic development of insects, the definitive head capsule is formed through the fusion of six primitive segments or somites. These segments include the preantennal, antennal, intercalary, mandibular, maxillary, and labial regions. This fusion creates a rigid structure that protects the brain and provides a stable platform for the articulation of various complex sensory organs and specialized feeding appendages.

4. (B) P-2, Q-1, R-4, S-3
The insect body is divided into specialized regions with distinct physiological roles. The head focuses on sensory perception and food ingestion, while the thorax serves as the primary center for locomotion and structural support. The pregenital abdomen houses the major organs for digestion and visceral functions, and the genital abdomen is specifically modified for reproduction and copulation.

5. (A) Acron
The acron is the non-segmental region located at the extreme anterior tip of a primitive arthropod embryo. It is situated in front of the true somites and typically bears the primitive brain and the protocerebrum. Unlike the segments that follow, the acron does not originate from a segmental coelomic sac, making it a primary, non-metameric part of the head.

6. (C) It results in an increased number of identical, unspecialized body segments
The evolutionary trend of tagmosis involves the specialization and differentiation of body segments, leading to regional functional groups. This process typically results in a reduction or fusion of segments rather than an increase in identical ones. It often features the concentration of segmental ganglia and the anatomical modification of appendages to suit specific ecological tasks like feeding, movement, or defense.

7. (A) Cuticle, epidermis, basement membrane
The insect integument is a complex organ composed of three fundamental layers. The outermost part is the cuticle, which provides protection and structural support. Directly beneath the cuticle lies the epidermis, a single layer of living cells responsible for secreting the cuticle. The innermost layer is the basement membrane, which separates the epidermal cells from the underlying body cavity.

NODIA

8. (C) A is true but R is false.
The epicuticle is the outermost layer of the insect cuticle and is vital for preventing water loss and desiccation. While it contains lipids and waxes that provide waterproofing, it does not contain chitin microfibrils or sclerotin. Those structural components are instead located within the thicker procuticle layers, such as the exocuticle and endocuticle, which provide mechanical strength rather than waterproofing.

9. (B) N-acetyl-D-glucosamine
Chitin is a major structural polysaccharide found in the insect procuticle that provides both strength and flexibility. Chemically, it is a long-chain polymer of N-acetyl-D-glucosamine units linked by beta-1,4-glycosidic bonds. This molecule is structurally similar to cellulose but contains nitrogen-containing groups, allowing for a high degree of hydrogen bonding between

adjacent chains to form durable and resilient microfibrils.

10. (B) I and III
Sclerotization is the biochemical process that hardens the insect cuticle by cross-linking cuticular proteins with quinones. This reaction primarily occurs in the exocuticle shortly after moulding, providing the necessary mechanical strength and rigidity to the exoskeleton. Sclerotization makes the cuticle insoluble in water and chemical solvents, but it typically does not occur in the flexible, unsclerotized endocuticle layer.

11. (D) The exocuticle is sclerotized and pigmented, while the endocuticle is unsclerotized and flexible
The exocuticle and endocuticle are the two primary components of the procuticle. The exocuticle undergoes sclerotization and pigmentation, resulting in a hard, dark, and rigid outer layer. In contrast, the endocuticle remains unsclerotized and flexible, providing the necessary resilience for the exoskeleton. Both layers contain chitin, but their physical properties differ significantly due to the presence or absence of cross-linking.

12. (A) Resilin
Resilin is a specialized cuticular protein characterized by its exceptional elasticity and ability to store mechanical energy. It is found in specific regions of the exoskeleton, such as the wing hinges and the jumping mechanisms of fleas and locusts. When compressed, resilin stores energy that can be released almost instantaneously, allowing for the rapid and powerful movements required for flight.

13. (B) Synthesis of circulating hemolymph proteins
The insect epidermis is a multifunctional cellular layer that secretes all components of the cuticle and produces moulting fluid during the ecdysis cycle. It also reabsorbs the breakdown products of the old cuticle to conserve nutrients. However, the synthesis of circulating proteins found in the hemolymph is primarily the function of the fat body rather than the epidermal cell layer.

14. (B) II, IV, I, III
The insect moulting cycle follows a precise chronological sequence of cellular and biochemical events. First, epidermal cells enlarge and undergo mitotic division to prepare for growth. This is followed by the secretion of a new epicuticle to protect the underlying cells. Subsequently, moulting fluid is released into the space to digest the old endocuticle, allowing the insect to reabsorb essential nutrients.

15. (A) Dermal gland cells
Dermal glands are specialized cells within the epidermis that possess long ducts extending through the cuticle to the surface. Their primary role is to secrete the cement layer, which forms the outermost protective coating of the epicuticle. This cement layer protects the underlying wax layer from abrasion and helps maintain the integrity of the insect's waterproof barrier against environmental stress.

16. (C) It is an amorphous layer composed of neutral mucopolysaccharides and collagen-like proteins
The basement membrane serves as the innermost boundary of the integument, supporting the epidermal cells. It is not cellular but rather an amorphous, non-chitinous layer composed of neutral mucopolysaccharides and collagen-like proteins. This structure acts as a selective barrier, regulating the exchange of nutrients, hormones, and waste products between the hemolymph in the body cavity and the overlying epidermis.

17. (D) The new cuticle is protected by a newly secreted, enzyme-resistant epicuticle
During the moulting process, the moulting fluid contains potent proteolytic and chitinolytic enzymes designed to break down the old endocuticle. The newly synthesized cuticle remains undamaged because it is shielded by a recently secreted, enzyme-resistant epicuticle. This protective layer acts as a chemical barrier, ensuring that the digestion process is restricted to the old cuticle layers destined to be shed.

18. (C) Nutrient and hormone exchange between the hemolymph and the epidermis
The basement membrane is a crucial physiological interface that regulates the passage of molecules between the circulatory system and the integument. Disruption of its integrity would immediately impair the transport of essential nutrients and regulatory hormones to the epidermal cells. This would likely inhibit the normal growth and secretory activities of the epidermis, potentially leading to widespread failures in the moulting cycle.

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19. (B) A seta has an articulated base (alveolus), while a spine is a rigid, unarticulated outgrowth
A true seta is a specialized multicellular outgrowth of the integument characterized by an articulated base known as an alveolus. This articulation allows the seta to move, often serving a sensory function. In contrast, a spine is a rigid, unarticulated extension of the entire body wall. Unlike setae, spines lack a basal socket and are immovable parts of the exoskeleton.

20. (A) P-4, Q-3, R-1, S-2
Insect cuticular outgrowths are classified by their structure and origin. Microtrichia are minute, non-articulated subcellular projections. Spurs are movable, articulated structures typically found on the tibia. Scales are flattened, modified macrotrichia that often provide structural coloration. Setae are articulated, multicellular outgrowths that perform sensory or protective functions. Each type represents a specific modification of the integument for diverse ecological and physiological needs.

21. (A) Microtrichia
Microtrichia are minute, hair-like projections of the cuticle that are fixed and non-articulated. Unlike macrotrichia or setae, they are formed as subcellular extensions of the cuticle without the direct involvement of specialized trichogen and tormogen cells. These structures are often very dense and can function in increasing surface area, providing water repellency, or affecting the aerodynamic properties of the insect's wings.

22. (D) I, II and III
Tibial spurs are significant morphological features used extensively in insect taxonomy for identification. These structures are articulated, multicellular outgrowths that possess a basal membranous joint, allowing them a degree of mobility. Unlike fixed spines, spurs can be moved by internal pressure or specific musculature. They are commonly found at the distal end of the tibia and serve various mechanical and sensory purposes.

23. (A) Trichogen cell – secretes the setal shaft; Tormogen cell – forms the setal membrane/ socket
The development of a sensory seta involves specialized epidermal cells with distinct roles. The trichogen cell is responsible for secreting the chitinous shaft of the seta, determining its length and shape. Simultaneously, the tormogen cell forms the surrounding setal membrane or socket, which provides the necessary articulation for movement. Together with a sensory neuron, these cells create a functional mechanoreceptor.

24. (D) Microscopic ridges on flattened scales
The vibrant structural coloration in Morpho butterflies is produced by the physical interaction of light with microscopic structures on the wing scales. These scales feature dense, nanoscopic ridges and lamellae that cause light interference and diffraction. Unlike pigment-based colors, structural colors do not fade and are entirely dependent on the precise geometric arrangement of the cuticular material on the surface of the scales.

25. (B) Apodemes
Apodemes are internal ridges or ingrowths of the insect exoskeleton that serve as primary sites for muscle attachment. They are formed by the invagination of the body wall and provide mechanical leverage for the insect's musculature. By increasing the internal surface area, apodemes allow for the attachment of large muscle bundles, which is essential for powerful movements like jumping, flying, and chewing.

NODIA

26. (A) Both A and R are true and R is the correct explanation of A.
The cranial tentorium is a vital internal framework that reinforces the insect head capsule against the mechanical stresses of feeding. It is formed during development through the inward invagination of the cuticle at specific points known as the anterior and posterior tentorial pits. This skeletal structure provides essential support for the brain and serves as the attachment point for the mandibular muscles.

27. (D) Apophysis
An apophysis is a specific type of internal apodeme that takes the form of a distinct, peg-like or finger-like projection. While sulci and sutures represent external grooves or lines of fusion, an apophysis extends deep into the body cavity to provide a localized and sturdy point for muscle insertion. These structures are crucial for the mechanical operation of specialized appendages and internal organs.

28. (A) Ventral nerve cord
The insect tentorium is an internal skeletal structure composed of several fused arms, including the anterior arms, posterior arms, and the central corporotentorium, also known as the tentorial bridge. These components collectively brace the head capsule and support the mouthpart muscles. The ventral nerve cord, however, is a part of the central nervous system and is not a structural component of the tentorium.

29. (B) Phragmata
Phragmata are large, plate-like internal apodemes that extend from the thoracic terga into the body cavity of flying insects. They are specifically designed to provide massive surface areas for the attachment of the longitudinal dorsal muscles responsible for the power stroke in flight. These structures are most highly developed in the pterothorax, where they ensure the mechanical integrity of the flight system.

30. (B) Inability to effectively utilize mandibular muscles for chewing
The anterior arms of the tentorium provide the primary structural support and attachment sites for the powerful muscles that operate the mandibles. If these arms were absent, the head capsule would lack the necessary internal bracing to withstand the high forces generated during feeding. Consequently, the insect would be unable to exert enough pressure to cut or crush food effectively, severely impairing its survival.

31. (A) It shifts the functional segment boundary to include the sclerotized region behind the primary fold
Secondary segmentation is a modification of the primitive body plan where the functional boundary of a segment shifts. In this arrangement, the sclerotized region behind the primary intersegmental fold becomes part of the following segment. This allows for the development of flexible intersegmental membranes between hardened sclerites, which is essential for movement in insects with a heavily sclerotized and rigid exoskeleton.

32. (A) I, II, III and IV
Insect segmentation varies between developmental stages and levels of sclerotization. Primary segmentation is found in soft-bodied larvae, while secondary segmentation is characteristic of sclerotized adults. In secondary segments, longitudinal muscles attach to the antecostae, spanning the functional intersegmental membranes. These membranes are derived from the posterior part of the preceding primary segment, allowing for body flexibility and the telescoping movement of the abdomen.

33. (D) Intersegmental membranes
Intersegmental membranes are flexible, unsclerotized areas of the integument that connect adjacent hardened sclerites. These membranes are essential for providing the body wall with the flexibility needed for movement, respiration, and expansion. By acting as joints between rigid segments, they allow the insect to perform complex maneuvers such as bending, stretching, and the telescoping of the abdominal segments during locomotion or egg laying.

34. (C) They attach directly to the flexible intersegmental membranes
In adult insects with secondary segmentation, longitudinal body muscles do not attach to the flexible intersegmental membranes themselves. Instead, they attach to rigid internal ridges known as antecostae. These muscles span across the intersegmental membranes, and their contraction draws the adjacent sclerotized segments closer together. Attaching to rigid sclerites ensures that the force generated by the muscles effectively results in body movement and telescoping.

35. (B) Primary segmentation
Caterpillars and other soft-bodied larvae exhibit primary segmentation, where the body segments are defined by simple transverse folds in the integument. Because these insects lack heavy sclerotization, their entire body wall remains relatively flexible. This structural arrangement allows the larva to move using peristaltic waves of muscle contraction, which would be impossible with the rigid, sclerotized plates characteristic of secondary segmentation.

36. (D) Acrotergite
The acrotergite is the narrow, hardened anterior margin of a secondary segment located in front of the antecostal sulcus. It represents a portion of the original primary segment that has become functionally associated with the segment behind it. The acrotergite provides a stable point for muscle attachment and helps maintain the

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structural integrity of the segment during the telescoping movements of the insect's body.

37. (A) Pleura
A typical insect body segment is structured like a box, consisting of four primary sclerotized regions. The dorsal region is the tergum, and the ventral region is the sternum. The two lateral regions, located on either side of the segment, are known as the pleura. These pleural regions are particularly important in the thorax, where they provide support and articulation for the legs and wings.

38. (A) P-2, Q-1, R-3, S-4
Insect segments are defined by specific sclerotized plates located at different anatomical positions. The tergum is the dorsal plate of any segment, while the sternum is the ventral plate. The pleuron refers to the lateral region of the segment. In the thoracic region, the dorsal sclerite is specifically referred to as the notum, which is subdivided to facilitate the mechanics of flight.

39. (A) Sulcus
In modern entomological morphology, a sulcus is a functional groove on the external surface of the exoskeleton that marks the internal invagination of the cuticle. This invagination forms an internal ridge or apodeme, which provides structural reinforcement or a site for muscle attachment. Distinguishing a sulcus from a suture is important, as a suture typically represents a line of fusion between sclerites.

40. (D) Episternum and epimeron
The pleural sulcus is a prominent vertical or oblique groove on the thoracic pleuron that provides internal structural support. This sulcus divides the pleuron into two distinct sclerites: the anterior episternum and the posterior epimeron. This division is critical for the mechanical organization of the thorax, as it provides the necessary framework for the attachment of leg muscles and the support of the wings.

41. (A) I, II and IV
Anatomical landmarks on the insect exoskeleton serve different structural roles. A true sulcus is an external groove indicating an internal ridge, providing reinforcement. A suture is a line where two previously separate sclerites have fused together. In contrast, the ecdysial line is a specialized, weakly sclerotized region that is designed to rupture during moulting, rather than providing structural strength to the exoskeleton.

42. (C) Loss of continuous body flexibility, requiring joints with membranes
Extensive sclerotization in adult insects provides significant protection and structural support but results in a loss of continuous body flexibility. To allow for movement, the rigid exoskeleton must be divided into separate sclerites connected by flexible, unsclerotized intersegmental membranes. These membranes act as joints, enabling the insect to perform necessary movements despite the overall hardness and rigidity of its protective outer covering.

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43. (D) Serving as the primary attachment sites for large striated muscles
Unsclerotized intersegmental membranes are essential for providing flexibility, allowing for abdominal expansion during feeding and the telescoping movement of segments. However, they are not suitable as primary attachment sites for large striated muscles. These muscles require the rigid support provided by sclerotized internal ridges and apodemes to effectively transmit the force of contraction into body or appendage movement without deforming the integument.

44. (A) Hypognathous
A hypognathous head orientation is characterized by mouthparts that are directed downwards, positioned perpendicular to the long axis of the insect's body. This arrangement is common in generalized herbivorous insects, such as grasshoppers and cockroaches, that feed on substrates directly beneath them. It allows the mandibles to work efficiently in a horizontal plane for cutting and grinding vegetation or other organic matter.

45. (B) Hypognathous → Prognathous → Opisthognathous
Insect head orientations are classified based on the direction of the mouthparts relative to the body axis. In the hypognathous condition, mouthparts are directed ventrally. In the prognathous condition, the mouthparts are directed anteriorly or forward. The opisthognathous condition features mouthparts that are directed posteroventrally, often appearing to arise from between the forelegs, which is typical of many sap-sucking insects.

46. (B) Coleoptera
The order Coleoptera, comprising the beetles, is a classic example of an insect group that often exhibits a prognathous head orientation. This forward-directed mouthpart arrangement is particularly advantageous for predatory beetles, as it positions the mandibles at the front of the head. This allows for the active pursuit, capture, and manipulation of prey encountered during foraging on the ground or within various substrates.

47. (A) Plant-sap sucking true bugs (Hemiptera)
The opisthognathous head orientation is a specialized adaptation found predominantly in the order Hemiptera, which includes plant-sap sucking true bugs. In these insects, the piercing-sucking mouthparts are directed backwards and lie against the ventral surface of the body when not in use. This streamlined arrangement facilitates the insertion of the stylets into plant tissues while the insect maintains a low profile.

48. (C) Cockroaches
Head orientation is a key diagnostic feature in insect morphology. Cockroaches typically possess a hypognathous head, where the mouthparts are directed downwards for feeding on various organic substrates. Grasshoppers also share this orientation. In contrast, tiger beetles are prognathous for predation, while cicadas and other hemipterans are opisthognathous to accommodate their specialized piercing-sucking beaks during sap feeding from plant hosts.

49. (A) Both A and R are true and R is the correct explanation of A.
Predatory insects such as carabid beetles typically have a prognathous head, where the mouthparts are directed forward. This orientation is a functional adaptation that aligns the mandibles with the direction of travel, facilitating the pursuit and capture of prey. By having the jaws at the leading edge of the head, the insect can more efficiently seize and manipulate its food during active hunting.

50. (C) Between the bases of the forelegs
In insects with an opisthognathous head orientation, such as many members of the order Hemiptera, the mouthparts are directed backwards along the ventral side of the body. Because of this extreme posterior tilt, the base of the beak or rostrum often appears to arise from the region between the bases of the forelegs. This configuration protects the delicate feeding apparatus when it is not being utilized.

51. (B) Vertex
The vertex is the dorsalmost region of the insect head capsule, located between and behind the compound eyes. It represents the top of the "skull" and often contains the lateral ocelli. The vertex provides the structural transition between the face and the posterior regions of the head. Its size and shape vary significantly among different insect orders and are used in taxonomic identification.

52. (D) Frons
The frons is the large, central facial area of the insect head capsule, situated anteriorly below the vertex and above the clypeus. It is typically bordered laterally by the frontal sulci and often bears the median ocellus. The frons serves as a major structural component of the face and provides the surface area for the attachment of various internal muscles associated with the mouthparts.

53. (A) P-2, Q-3, R-1, S-4
The insect cranial capsule is divided into several regions based on their anatomical position. The genae are the lateral areas below the eyes, acting as "cheeks." The clypeus is the anterior plate just above the labrum. The occiput is the posterior surface behind the vertex. The postgena is the lateral area located posterior to the gena. These regions are separated by specific sulci.

54. (C) Labrum
The clypeus is an important sclerite on the lower face of the insect head. At its ventral margin, it articulates directly with the labrum, which functions as the "upper lip" of the mouthparts. This articulation is often flexible, allowing the labrum to move independently during feeding. The clypeus and labrum together protect the mandibles and help contain food within the preoral cavity.

55. (A) The labium
The submentum is the large, basal-most sclerite of the insect labium, which represents the "lower lip." It is part of the postmentum and serves to anchor the labial structure to the head capsule. The labium is formed by the evolutionary fusion of the second pair of maxillae, and the

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submentum provides the structural foundation for the more distal and mobile parts like the prementum.

56. (D) I, II and III
The insect head capsule is reinforced by several functional sulci. The epistomal sulcus separates the frons from the clypeus, providing internal bracing. The subgenal sulcus is located just above the bases of the mandibles and maxillae. The circumocular sulcus reinforces the head wall around the compound eyes. Collectively, these sulci strengthen the head against mechanical stress and provide sites for internal muscle attachment.

57. (B) Scape
The scape is the first and most proximal segment of the insect antenna. It articulates directly with the head capsule within the antennal socket. The scape is often larger than the succeeding segments and provides the structural base for the entire antennal structure. Movement of the antenna is primarily controlled by muscles that originate within the head and insert onto the base of the scape.

58. (C) Pedicel
Johnston's organ is a highly specialized mechanoreceptor found within the pedicel, which is the second segment of the insect antenna. It consists of a large number of scolopidia that detect the movement of the distal flagellum relative to the pedicel. This organ is essential for sensing vibrations, air currents, and, in some insects, sound, playing a critical role in navigation and communication.

59. (D) Auditory reception of female wingbeat frequencies
In male mosquitoes, Johnston's organ is exceptionally well-developed and functions as a sophisticated auditory receiver. It is tuned specifically to detect the wingbeat frequencies of flying females. When the female's wings vibrate the male's antennal flagellum, Johnston's organ in the pedicel converts these mechanical vibrations into neural signals. This allows the male to locate and pursue a potential mate during flight.

60. (A) Both A and R are true and R is the correct explanation of A.
In all members of the Ectognatha, which includes the true insects, the antennal flagellum lacks intrinsic muscles. Instead, the movement of the flagellum is mediated by muscles that originate in the scape and insert on the base of the pedicel. Because the flagellum segments are not independently motile, the antenna moves as a unit from its basal joints, which is a key diagnostic feature.

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61. (B) Collembola
While true insects (Ectognatha) lack musculature in the antennal flagellum, primitive hexapods such as Collembola (springtails) and Diplura possess intrinsic muscles within each flagellar segment. This anatomical feature allows them to move each part of the antenna independently. This "segmented" antenna is considered a primitive condition that was lost during the evolution of the more advanced and streamlined antennal structures found in the Ectognatha.

62. (B) The flagellum is typically composed of multiple true segments, each with independent musculature
In a generalized insect antenna, the flagellum is composed of multiple subsegments called flagellomeres. However, in true insects, these flagellomeres lack independent musculature and are therefore not considered "true" segments. The antenna is anchored by the scape and pedicel, which articulate via a process called the antennifer. The flagellum is primarily a sensory structure, densely covered with various types of olfactory and tactile sensilla.

63. (A) A capitate antenna has an abrupt terminal knob, while a clavate antenna swells gradually
Capitate and clavate are two types of clubbed antennae. A capitate antenna is characterized by an abrupt and distinct terminal knob, where the final few flagellomeres are significantly larger than the preceding ones. In contrast, a clavate antenna shows a gradual increase in the diameter of the flagellomeres towards the tip, resulting in a more subtle, club-like appearance without a sharp transition.

64. (B) P-3, Q-4, R-2, S-1
Insect antennae exhibit diverse forms adapted for specific functions. Plumose antennae are feathery and found in male mosquitoes.

Geniculate antennae are knee-jointed, common in ants and wasps. Aristate antennae feature a large bristle called an arista, characteristic of house flies. Lamellate antennae have leaf-like terminal segments, which are the hallmark of scarab beetles. These specialized shapes maximize sensory efficiency for various chemical and physical cues.

65. (D) Arista
The arista is a specialized, bristle-like structure found on the antennae of higher flies, such as the house fly. It typically arises from the dorsal or terminal surface of the enlarged third antennal segment. The arista is highly sensitive to air currents and vibrations, functioning as a mechanoreceptor that provides the fly with critical information about its speed and direction during flight.

66. (C) III only
Specialized antennal shapes serve different sensory needs. Filiform antennae are thread-like, while moniliform antennae resemble a string of beads. Serrate antennae are saw-toothed, and setaceous antennae are tapering. Pectinate antennae have comb-like processes, but they are typically characteristic of males in certain moth groups rather than female mosquitoes, who possess pilose antennae. The plumose antenna is the highly feathery type found in male mosquitoes.

67. (B) Maximize surface area for detecting airborne chemical signals or sounds
The feathery structure of a plumose antenna is an evolutionary adaptation designed to maximize the total surface area available for sensory reception. By increasing the number of fine branches, the insect can pack more olfactory sensilla and mechanoreceptors onto the antenna. This enhanced sensitivity is crucial for detecting minute concentrations of pheromones or subtle sound vibrations, such as the wingbeats of a mate.

68. (D) Geniculate
Geniculate antennae are characterized by a sharp, knee-like bend. This bend occurs between the elongated first segment, the scape, and the remaining segments of the antenna. This structural modification is common in insects like ants, bees, and weevils, as it allows the antenna to be folded or maneuvered with great precision, facilitating the tactile and chemical exploration of their environment and food sources.

69. (A) Biting and chewing
Biting and chewing mouthparts are considered the most primitive and generalized type among insects. This arrangement features strong mandibles for cutting and crushing, and is found in many diverse groups such as grasshoppers, beetles, and dragonflies. From this basic structural plan, all other specialized mouthparts, such as those for piercing, sucking, or siphoning, have evolved through the modification and elongation of various components.

70. (C) Mandibles
In biting and chewing mouthparts, the mandibles are the primary feeding appendages. They are heavily sclerotized, unsegmented, and typically possess sharp incisor regions for cutting and broad molar regions for crushing food. These jaws operate horizontally, and their powerful movement is driven by massive adductor muscles within the head capsule. The mandibles are essential for processing solid food materials before they enter the digestive tract.

71. (C) II, I, III
A generalized insect maxilla consists of several distinct parts arranged from the head outward. The cardo is the basal segment that articulates with the head capsule. It is followed by the stipes, which forms the main body of the maxilla. Attached to the distal end of the stipes are the inner lacinia and the outer galea, along with the sensory maxillary palp. This sequence is fundamental to the structure of chewing mouthparts.

72. (D) The second pair of maxillae
The insect labium, often referred to as the "lower lip," is a complex structure formed by the evolutionary fusion of the second pair of maxillae. This fusion occurs along the midline, creating a single functional unit that closes the preoral cavity from below. The labium usually consists of a basal postmentum and a distal prementum, the latter of which bears the labial palps and various terminal lobes.

73. (B) Hypopharynx
The hypopharynx is a median, tongue-like lobe located in the preoral cavity of chewing insects. It is situated between the mandibles and maxillae

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and above the labium. The hypopharynx plays a crucial role in feeding by manipulating food and helping to mix it with saliva. The salivary duct typically opens onto or near its base, allowing for the initial chemical processing of food before ingestion.

74. (B) I and III
The labrum is a single, plate-like sclerite that functions as the "upper lip," covering the mandibles from the front. It is not an appendage but a portion of the head capsule. Its inner surface is often modified into a sensory region called the epipharynx. While the labrum does bear sensory sensilla, the primary taste receptors in many biting insects are more concentrated on the palps and other mouthparts.

75. (D) Labium
In the piercing-sucking mouthparts of a mosquito, the labium is modified into a long, flexible, gutter-like sheath. This sheath protects the six delicate stylets, which include the labrum, two mandibles, two maxillae, and the hypopharynx. During feeding, the labium bows back, allowing the stylets to pierce the host's skin. The labium itself does not enter the wound but remains on the surface to stabilize the stylets.

76. (A) Sponging mouthparts utilize pseudotracheae to soak up liquids, whereas chewing-lapping mouthparts utilize a hairy glossa to lap nectar
Sponging mouthparts, found in house flies, feature large labellar lobes with fine channels called pseudotracheae that soak up liquids through capillary action. In contrast, chewing-lapping mouthparts, characteristic of honey bees, involve a specialized long, hairy glossa that "laps" up nectar. While bees also possess functional mandibles for manipulating wax, sponging flies have lost their mandibles and rely entirely on liquid food sources for their nutrition.

77. (D) A false but R is true.
The siphoning proboscis in adult Lepidoptera is formed by the extreme elongation of the maxillary galeae, not the mandibles, which are usually vestigial. These galeae lock together to form a central feeding tube. The proboscis remains coiled under the head when at rest due to the inherent elasticity of its cuticle. It is extended only when the insect uses internal fluid pressure or muscle contraction to drink nectar.

78. (B) Sponging
Pseudotracheae are specialized, transverse capillary channels located on the large, pad-like labella of sponging mouthparts. These channels are reinforced by incomplete rings of sclerotized cuticle, which keep them open. When the labella are pressed against a liquid food source, the pseudotracheae collect the fluid through capillary action and direct it toward the central food canal, where it is then sucked up into the insect's esophagus.

79. (A) Galeae and labial palps tightly surrounding the glossa
In the chewing-lapping mouthparts of honey bees, a temporary food canal is formed during feeding. This canal is created by the close juxtaposition of the elongated galeae of the maxillae and the labial palps, which wrap around the long, central glossa. This structural arrangement creates a tube through which nectar can be efficiently sucked up into the mouth while the glossa moves back and forth to lap the liquid.

80. (C) Completely lack maxillary palps and labial palps
The piercing-sucking mouthparts of Hemiptera differ significantly from those of mosquitoes. A major diagnostic difference is that Hemiptera completely lack both maxillary and labial palps. Their mouthparts consist of a four-segmented labium that forms a sheath for the mandibular and maxillary stylets. The maxillae are uniquely interlocked to form two separate internal channels: one for the ingestion of food and another for the injection of saliva.

81. (D) Mesothorax and metathorax combined
The pterothorax is the functional tagma of the insect body responsible for flight. It consists of the second and third thoracic segments, specifically the mesothorax and the metathorax. These two segments are often fused or closely integrated to provide a rigid framework that supports the wings and the powerful muscles required for flight. The prothorax, which never bears wings, is excluded from this specialized structural unit.

82. (C) Prothorax
In highly specialized flying insects like Diptera and Hymenoptera, the prothorax is typically the smallest and least developed thoracic segment. Because the primary flight apparatus is

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located on the mesothorax and metathorax, the prothorax is often reduced to a narrow collar-like structure. Its main function in these groups is to support the head and the first pair of legs, while the pterothorax dominates the thoracic region.

83. (A) I and II
The pterothorax is the wing-bearing region of the thorax, and its structure is highly specialized for flight. It bears the articulating wings on the mesothorax and metathorax. The terga of these segments are often divided into distinct sclerites, such as the scutum and scutellum, to allow for the mechanical deformation necessary for wing movement. Additionally, the pterothorax possesses large internal phragmata that provide attachment for flight muscles.

84. (C) Pleural wing process
The pleural wing process is a specialized, sclerotized projection located at the dorsal edge of the thoracic pleuron. It serves as the primary fulcrum or pivot point for the insect wing during flight. The wing base rests upon this process, allowing it to rock back and forth as the thoracic muscles contract. This articulation is critical for translating the vertical movements of the thorax into the complex wing strokes.

85. (A) The spiracles are usually located directly on the heavily sclerotized nota
Thoracic spiracles are the external openings of the tracheal system through which gases are exchanged. In adult insects, there are typically two pairs of these openings. They are not located on the heavily sclerotized dorsal nota, but rather in the more flexible pleural regions or the intersegmental membranes between the segments. This placement prevents the spiracles from interfering with the mechanics of the rigid flight-supporting sclerites.

86. (C) Furcae
Furcae are internal, Y-shaped sternal apophyses found within the thoracic segments, particularly in the pterothorax. They are formed by the invagination of the sternal cuticle and provide essential sites for the attachment of the ventral longitudinal muscles and the muscles that operate the legs. By reinforcing the ventral side of the thorax, furcae help maintain the structural integrity of the body during the strenuous activities of locomotion and flight.

87. (A) Coxa
The coxa is the basal-most segment of a typical insect leg. It serves as the primary point of articulation between the leg and the thoracic pleuron. The shape and size of the coxa vary depending on the insect's mode of locomotion. It is attached to the body by a flexible membrane and often articulates with specialized sclerites like the trochantin, allowing for a wide range of leg movements.

88. (A) Coxa → Trochanter → Femur → Tibia → Tarsus → Pretarsus
A generalized insect leg is composed of six primary segments arranged from the body outward. These are the coxa, which attaches to the thorax; the small trochanter; the large, muscular femur; the slender tibia; the tarsus, which is often subdivided into several tarsomeres; and the terminal pretarsus. This segmented structure provides the flexibility and leverage needed for diverse types of movement, from walking to specialized activities like jumping.

89. (B) Pretarsus
The pretarsus is the terminal part of the insect leg, located beyond the last tarsal segment. Its most prominent features are the paired claws, or ungues, which the insect uses to grip various surfaces. In addition to the claws, the pretarsus may bear various specialized adhesive structures, such as the arolium or pulvilli. While small, the pretarsus is essential for maintaining stability and traction during locomotion and resting.

90. (C) An arolium is a median pad between claws, while an empodium is a spine-like or pad-like structure
Both the arolium and the empodium are specialized structures located on the pretarsus between the claws. An arolium is typically a single, median adhesive pad that helps the insect walk on smooth surfaces. An empodium is another median structure that can be either spine-like or pad-like in appearance. These structures vary significantly between different insect groups and are often important diagnostic features used in identification and classification.

91. (D) Pulvilli
Pulvilli are paired, pad-like adhesive structures located at the base of each claw on the insect pretarsus. These structures are common in many flies, such as the house fly, and are covered with

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fine, secretory hairs that produce an adhesive substance. This allows the insect to walk on incredibly smooth or vertical surfaces, including glass, by utilizing capillary forces and molecular adhesion provided by the pulvillar secretions.

92. (A) Femur
In the typical insect leg, the trochanter is the second segment, following the coxa. While it articulates flexibly with the coxa, it is often fused or articulated immovably with the femur. Functionally, this means the trochanter and femur often move as a single unit. This structural arrangement provides a strong and stable base for the femur, which contains the powerful muscles responsible for the major movements of the leg.

93. (B) Saltatorial
Saltatorial legs are specialized for jumping and are most famously observed in the hind legs of grasshoppers and crickets. These legs are characterized by an greatly enlarged and muscular femur, which stores the energy required for powerful leaps. The tibia is typically long and slender, providing the leverage needed to propel the insect into the air. This modification is a key survival adaptation for escaping predators and traversing large distances.

94. (B) Fossorial
Fossorial legs are highly specialized for digging and burrowing. In the mole cricket, the forelegs are significantly modified for this purpose, featuring a broad, flattened structure and heavy sclerotization. The segments are equipped with strong, tooth-like projections that act like a shovel to displace soil. These modifications allow the insect to navigate underground environments efficiently, where it searches for food or creates protective burrows and nesting sites.

95. (B) I, II, III and IV
Insect legs are remarkably diverse, with modifications suited for various ecological roles. Raptorial legs are adapted for grasping prey, while natatorial legs feature setae for swimming. Corbiculate legs possess a pollen basket for collection, and cursorial legs are streamlined for rapid running. However, fossorial legs are specifically for digging, not jumping; the correct term for jumping legs, such as those found in fleas or grasshoppers, is saltatorial.

96. (C) Raptorial
Raptorial legs are specialized for the rapid capture and holding of prey. They are characterized by an elongated coxa that provides an increased range of motion and a femur and tibia that are often armed with interlocking spines. When a predator like a praying mantis strikes, the tibia folds tightly against the femur, trapping the prey between the sharp spines. This modification is an efficient mechanism for secure prey handling.

97. (D) Tibia
The corbicula, or pollen basket, is a specialized structure found on the hind legs of worker honey bees and their relatives. It is located on the outer, concave surface of the hind tibia and is surrounded by a fringe of long, stiff hairs. This "basket" allows the bee to securely transport large quantities of pollen from flowers back to the hive, where it is used as a primary protein source.

98. (C) Dense rows of long, stiff setae serving as oars
Natatorial legs are an adaptation for life in aquatic environments, found in various water beetles and bugs. To facilitate efficient swimming, these legs are often flattened and equipped with dense rows of long, stiff setae along the margins. During the swimming stroke, these setae fan out to increase the surface area of the leg, functioning like oars to provide maximum propulsion through the water while folding back during recovery.

99. (B) Praying mantis
Cursorial legs are generalized legs modified for rapid running on terrestrial surfaces. They are typically long and slender, as seen in cockroaches and tiger beetles. In contrast, the praying mantis has highly specialized raptorial forelegs designed for grasping and holding prey. While its middle and hind legs are cursorial, the front legs are so fundamentally modified for predation that they do not represent the cursorial type found in the other listed insects.

100. (D) Costal margin
The costal margin is the anterior edge of the insect wing. It is typically the most heavily reinforced part of the wing, as it must cut through the air and withstand the highest mechanical stresses during the flight stroke. The costa vein runs along this margin, providing the necessary rigidity. This leading edge is crucial

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for generating the lift and aerodynamic forces required for controlled and efficient flight.

101. (A) Apical angle
The apical angle is the distinct corner of the insect wing where the anterior costal margin meets the outer apical margin. This point represents the distal tip of the wing. The shape of the apical angle can vary significantly between species, being sharp in some and rounded in others. It is an important morphological landmark used in describing wing shapes and in the taxonomic identification of various insect groups.

102. (C) Axillary sclerites
Axillary sclerites are a group of small, sclerotized plates located within the flexible membrane at the base of the insect wing. They provide the necessary articulation between the wing and the thoracic notum. These sclerites are essential for the complex movements of flight, as they allow the wing to pivot and twist. In Neopteran insects, they also facilitate the folding of the wings flat over the abdomen when at rest.

103. (A) Median plate
The median plates are small sclerites located in the central area of the wing base, between the other axillary sclerites and the bases of the longitudinal veins. They are primarily associated with the prominent fold that separates the main flight area, or remigium, from the posterior vannal region. This fold is critical for the mechanics of wing folding, allowing the posterior portion of the wing to tuck neatly away when not in use.

104. (D) Jugal lobe
The jugal lobe is a small, proximal lobe located at the posterobasal base of the insect wing. It is separated from the vannal area by the jugal fold. While it is often reduced in many modern insect groups, it is well-developed in more primitive taxa. The jugal lobe can play a role in wing coupling mechanisms or provide additional surface area at the base of the wing during the flight cycle.

105. (B) Neopteran insects lack pleural wing processes entirely
Neopteran insects are defined by their ability to fold their wings over the abdomen, a process facilitated by the axillary sclerites. Muscles attached to the third axillary sclerite are responsible for pivoting the wing backward. However, they do not lack pleural wing processes; in fact, these processes remain the essential fulcrums upon which the wing articulates during the flight stroke. The fundamental mechanics of wing support remain consistent across flying insects.

106. (C) Comstock-Needham system
The Comstock-Needham system provides a universal nomenclatural framework for identifying insect wing venation. It identifies homologous longitudinal veins across different orders using a standardized set of names and abbreviations. This system is essential for comparative morphological studies and taxonomic descriptions, as it allows researchers to trace evolutionary modifications and reductions in wing patterns from a generalized, primitive insect ancestral model.

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107. (D) Costa (C)
In the generalized Comstock-Needham wing venation system, the Costa is the most anterior longitudinal vein. It typically runs along the leading edge, or costal margin, of the wing and is rarely branched. Because it occupies the position that encounters the most air resistance during flight, the Costa is often thickened and heavily sclerotized to provide the necessary structural support for the entire wing blade.

108. (C) Five
In the primitive Comstock-Needham wing venation plan, the Radius is a major longitudinal vein that typically divides into two primary branches: R1 and the Radial Sector. The Radial Sector then further subdivides into four additional branches, resulting in a total of five radial veins (R1 through R5) that reach the wing margin. This branching pattern is a fundamental reference point for analyzing the complex venation of many insect orders.

109. (B) Cross veins
Cross veins are short, transverse veins that connect adjacent longitudinal veins within the insect wing. They serve to reinforce the wing membrane and provide structural integrity to the wing's overall framework. By creating a network of cells, cross veins prevent the wing from tearing and help distribute the mechanical stresses encountered during flight. The arrangement

and number of cross veins are often important diagnostic characters in insect taxonomy.

110. (B) The Subcosta (Sc) never reaches the wing margin
In the generalized Comstock-Needham system, the Subcosta is the vein located immediately behind the Costa. While it is often reduced or short in many specialized insect groups, in the primitive condition, it typically divides into two branches that do reach the wing margin. Other characteristics of the system include the branching of the Cubitus and the Media, and the presence of usually unbranched Anal veins in the posterior region.

111. (A) Anal veins
The anal veins are the longitudinal veins located in the posterior, or vannal, region of the insect wing. They usually fan out from a common base associated with the third axillary sclerite. These veins provide structural support to the posterior portion of the wing and are particularly numerous in insects with... fine details. Their pattern is often used in the classification of higher insect taxa.

112. (C) Jugate
Jugate coupling is a primitive wing-locking mechanism found in certain moths, such as the Hepialidae. It involves a small, finger-like lobe called the jugum, which is located at the base of the forewing. This lobe extends backwards and overlaps the anterior margin of the hindwing, effectively tying the two wings together during flight. This ensures that the fore and hind wings function as a single aerodynamic unit for better flight control.

113. (D) A stout bristle or cluster on the hindwing that locks into a forewing retinaculum
In the frenate coupling mechanism common in higher Lepidoptera, the wings are locked together by a structure called the frenulum. This consists of one or more stout bristles arising from the anterior base of the hindwing. These bristles extend forward and are held in place by a specialized hook or a patch of hairs on the underside of the forewing, known as the retinaculum. This synchronization enhances flight performance.

114. (C) Amplexiform
Amplexiform coupling is a wing-linking mechanism that lacks specialized hooks, bristles, or lobes. Instead, it relies on the extensive overlapping of the broad forewing and hindwing margins. This arrangement is characteristic of true butterflies and some moths. The pressure of the air during flight keeps the overlapping surfaces together, ensuring that the wings move in unison. This represents a simplified but effective evolution of wing synchronization in advanced flying insects.

115. (B) Hamulate coupling
Hamulate coupling is the wing-locking mechanism used by bees, wasps, and other members of the order Hymenoptera. It consists of a row of minute, sclerotized hooks called hamuli, which are located along the anterior margin of the hindwing. During flight, these hooks engage with a folded posterior margin of the forewing. This strong mechanical connection allows the two wings to function as a single, efficient flight surface.

116. (D) The frenulum would have nothing to anchor to, disrupting synchronized flight
The retinaculum is an essential component of the frenate wing-coupling system, as it provides the anchor point for the frenulum. If a moth were to lose its retinaculum, the frenulum would be unable to lock into the forewing. This failure would prevent the fore and hind wings from moving together as a single unit, leading to unsynchronized wing beats and a significant decrease in the moth's overall flight efficiency and maneuverability.

117. (A) Males have a subcostal hook, while females have a cubital tuft of scales
In many moths with frenate coupling, the retinaculum exhibits distinct sexual dimorphism. In males, the retinaculum typically consists of a single, well-developed hook located on the subcostal vein of the forewing. In females, however, the retinaculum is often represented by a cluster or tuft of stiff scales or bristles located further back on the cubital vein. This morphological difference is a common feature used in the sexing of lepidopteran specimens.

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118. (C) It converts independent wings into a single surface, increasing flight efficiency
The primary evolutionary advantage of functional wing coupling mechanisms is the coordination of the fore and hind wings into a single aerodynamic surface. By locking the wings together, the insect can generate lift and thrust more efficiently than if the wings moved independently. This synchronization reduces turbulence and power loss, allowing for the improved flight speeds, stability, and maneuverability characteristic of advanced Neopteran insects.

119. (A) Elytra
Elytra are the thickened, heavily sclerotized forewings characteristic of the order Coleoptera. These wings are typically veinless and are not used for active flight. Instead, they serve as protective covers for the delicate, membranous hindwings and the dorsal surface of the abdomen. When the beetle is at rest, the elytra meet along a straight midline, shielding the insect from physical damage and reducing water loss.

120. (D) Hemelytra – Basal half thickened and corium-like, apical half membranous
Hemelytra are specialized forewings found in many true bugs of the order Hemiptera. They are characterized by a dual structure: the proximal portion, or corium, is thickened and leathery, providing protection, while the distal portion is thin and membranous. This apical part contains veins and contributes to flight. This unique combination of protection and aerodynamic function is a key diagnostic feature for most members of the suborder Heteroptera.

121. (B) Tegmina
Tegmina are the leathery, parchment-like forewings typical of insects in the orders Orthoptera and Dictyoptera. Unlike elytra, tegmina retain visible wing venation and are somewhat flexible. Their primary function is to protect the more delicate, fan-like hindwings that are used for flight. In many species, tegmina also play a role in camouflage or are modified to produce sound through stridulation during courtship and territorial displays.

122. (C) Halteres
In the order Diptera, the hindwings are highly modified into small, knob-like structures called halteres. These organs function as gyroscopic balancers that oscillate rapidly during flight. They provide the fly with immediate sensory feedback regarding its orientation in three-dimensional space, allowing for the exceptional maneuverability and stability characteristic of flies. The loss of these structures severely impairs the insect's ability to maintain controlled and directed flight.

123. (C) IV only
Wing modifications serve various ecological roles across different orders. Thrips have fringed wings, Strepsiptera have forewing halteres, and Lepidoptera wings are covered in scales. However, in Hemiptera, while the hemelytra provide some lift, the primary power for flight is usually generated by the membranous hindwings. The hemelytra function more as protective covers and aerodynamic surfaces rather than the sole or primary source of flight propulsion.

124. (A) Setae (macrotrichia)
The scales that cover the wings of moths and butterflies are evolutionarily derived from macrotrichia, which are large, articulated setae. Each scale is produced by a single trichogen cell and is anchored in a socket formed by a tormogen cell. These scales are flattened and often feature complex surface nanostructures that provide either chemical pigmentation or structural coloration, as well as providing thermal insulation and aerodynamic properties.

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125. (B) 11
The primitive and generalized insect abdomen is considered to consist of eleven true metameres, or segments. In the most ancestral condition, each of these segments could bear appendages. While modern adult insects show a reduction in the number of visible segments due to fusion or specialization, the embryonic development of most insects still reveals the presence of eleven distinct abdominal somites, reflecting this basic arthropod body plan.

126. (D) Segments 1 to 7
The pregenital region of the insect abdomen typically consists of the first seven segments. In most adult Pterygote insects, these segments lack functional appendages and are primarily involved in housing the internal visceral organs. The sternites and tergites of this region are often simple and uniform, though they may be modified for specialized functions like sound

production or defense in certain highly adapted insect groups.

127. (A) Segments 8 and 9
In female insects, the genital segments are specifically those that bear the primary reproductive structures and the appendicular ovipositor. These are almost universally the eighth and ninth abdominal segments. These segments are modified to house the valvifers and valvulae, which work together to facilitate the deposition of eggs. The morphological details of these segments are highly diverse, reflecting different egg-laying strategies across the various insect orders.

128. (C) Presence of functional spiracles on the 11th segment
The postgenital region of the insect abdomen consists of the segments following the genital ones, typically the tenth and eleventh segments. The eleventh segment often bears the cerci and terminal sclerites like the epiproct and paraprocts, which surround the anus. However, this terminal segment does not possess functional spiracles; respiratory openings are generally restricted to the more anterior abdominal segments, usually segments one through eight.

129. (D) The lateral pleural membranes
Abdominal spiracles are the external openings of the respiratory system. In most insects, they are located laterally on the abdominal segments, specifically within the flexible pleural membranes that connect the dorsal terga and ventral sterna. This position allows the spiracles to remain functional while the abdomen expands or contracts. There is typically one pair of spiracles per segment, usually present on the first eight abdominal segments.

130. (C) A reduction in the visible number of segments through fusion or telescoping
The evolutionary trend in higher insects is toward a reduction in the number of visible abdominal segments. This is achieved through the fusion of terminal segments or the telescoping of posterior segments into the preceding ones. This specialization often results in a more compact and functionally integrated abdomen, particularly in groups with advanced flight or complex reproductive behaviors, where only five to eight segments may be easily seen externally.

131. (B) Collophore
The collophore is a specialized, tube-like structure located on the ventral side of the first abdominal segment in Collembola. It plays a vital role in osmoregulation by absorbing water from the environment and is also involved in adhesion to smooth surfaces. This unique organ is one of the defining characteristics of springtails and is essential for maintaining their internal water balance in diverse terrestrial habitats.

132. (D) Furcula
The furcula is a specialized, forked jumping organ found on the fourth abdominal segment of most Collembola. When the insect is at rest, the furcula is held under tension against the ventral side of the abdomen. When released, it strikes the substrate with great force, propelling the springtail into the air. This rapid escape mechanism is a highly effective adaptation for avoiding predators in the soil and leaf litter.

133. (A) Hold the furcula under tension against the ventral abdomen
The tenaculum is a small, clasp-like structure located on the third abdominal segment of Collembola. Its primary function is to act as a catch or latch for the furcula. By holding the furcula in a cocked position against the ventral abdomen, the tenaculum allows the springtail to store mechanical energy. When the tenaculum releases its grip, the furcula snaps downward, facilitating the insect's characteristic jumping movement.

134. (C) Styli
Styli are small, unjointed, peg-like appendages found on the pregenital abdominal segments of primitive wingless insects, such as Archaeognatha and Thysanura. They are considered to be the evolutionary remnants of the ancestral biramous limbs that were once present on all body segments. In modern apterygotes, these structures are typically immovable and may provide sensory information or help support the abdomen during locomotion across irregular surfaces.

135. (A) They retain small, limb-like appendages on the first three segments
Protura are unique among hexapods because they retain small, rudimentary, limb-like appendages on the first three abdominal segments. These appendages are considered a primitive trait, representing the ancestral condition where all

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segments bore functional limbs. The presence of these abdominal legs, combined with the lack of antennae and eyes, makes Protura a highly distinct group that provides important clues about the early evolution of hexapods.

136. (C) Apterygote appendages like the collophore are homologous to the pterygote wings
Apterygotes and Pterygotes differ significantly in their abdominal morphology. While apterygotes often retain many primitive pregenital appendages like styli and the collophore, these are not homologous to the wings of Pterygotes, which are thoracic outgrowths of the body wall. Both groups can possess cerci on the eleventh segment, but the loss of abdominal appendages in adult Pterygotes is a major evolutionary shift toward specialization of the thoracic region.

137. (B) Insect ancestors possessed articulated appendages on all body segments
The presence of abdominal styli in primitive apterygote insects is of great evolutionary significance. These structures provide strong evidence for the theory that the ancestors of modern insects possessed functional, articulated appendages on every body segment. Over time, these limbs were lost or highly modified in the abdominal region of more advanced insects, while they were retained and specialized as legs in the thoracic region.

138. (C) Prolegs
Prolegs are fleshy, unjointed, and temporary abdominal appendages found in the larval stages of several insect orders, most notably Lepidoptera. Unlike the true jointed legs on the thorax, prolegs are outgrowths of the body wall operated by hydraulic pressure. They are typically found on abdominal segments three through six and on the final segment, providing the larva with the necessary grip and stability for movement on plants.

139. (D) Crochets
To improve their grip on diverse plant surfaces, the distal ends of lepidopteran prolegs are equipped with semicircles or circles of tiny, sclerotized hooks called crochets. These hooks function like Velcro, allowing the caterpillar to cling securely to leaves, stems, and silk threads. The arrangement and size of these crochets vary between species and are frequently used as diagnostic features in the identification of different larval families and genera.

140. (A) Tracheal gills
In the aquatic nymphs of Ephemeroptera, the abdomen bears lateral appendages modified into tracheal gills. These structures are rich in tracheoles and provide a large surface area for the diffusion of oxygen from the surrounding water into the insect's respiratory system. The gills can be moved rhythmically to create a water current, ensuring a constant supply of oxygenated water, which is essential for survival in aquatic habitats.

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141. (B) Dermaptera
In the order Dermaptera, commonly known as earwigs, the cerci are uniquely modified into unsegmented, heavily sclerotized forceps. These structures are used for a variety of tasks, including defense against predators, capturing prey, and assisting in the folding of the complex hindwings. The shape of the forceps is often sexually dimorphic, with males usually possessing more curved and elaborate forceps than those of the females.

142. (B) Median caudal filament – A long thread-like extension of the epiproct in silverfish and mayflies
Several terminal abdominal structures are found in both primitive and some advanced insects. The median caudal filament is a long, thread-like extension that arises from the epiproct. It is commonly found in apterygotes like silverfish and in the aquatic nymphs and adults of mayflies. This filament, along with the cerci, provides sensory information and can assist in stabilization during flight or movement across surfaces.

143. (A) Anal prolegs (claspers)
The final pair of prolegs, located on the last abdominal segment of a lepidopteran larva, is specifically known as the anal prolegs or claspers. These structures are typically stronger and more heavily equipped with crochets than the more anterior prolegs. They allow the caterpillar to anchor itself firmly to the substrate, providing a stable base while the front of the body reaches out to forage or move.

144. (C) The reduction or telescoping of the terminal abdominal segments
In many advanced adult insects, such as true bugs and certain flies, the cerci are either greatly reduced or entirely lost. This evolutionary trend is strongly correlated with the reduction or telescoping of the posterior abdominal segments. As these segments become more specialized for internal reproductive functions or are retracted into the body, the external appendages like cerci lose their primary sensory utility and are eventually lost.

145. (B) 8th and 9th
The true appendicular ovipositor is a complex organ formed from specialized structures on the eighth and ninth abdominal segments. These segments are modified to support the various valves and sclerites that comprise the egg-laying apparatus. This appendicular origin distinguishes it from substitute ovipositors, which are formed from the posterior segments themselves. The precise arrangement of these components is a fundamental feature of the female reproductive system.

146. (C) Endites (or gonapophyses)
Morphologically, the valvulae that make up the shaft of the insect ovipositor are considered to be homologous to the endites, or gonapophyses, of the ancestral segmental appendages. This means they are derived from the inner lobes of the limbs on the eighth and ninth segments. This evolutionary modification has transformed generalized walking or sensory structures into a specialized tool for the precise deposition and protection of eggs.

147. (B) Valvifers
Valvifers are the basal sclerites that support the valvulae and act as the primary pivot points for the movement of the ovipositor. They are derived from the coxal portions of the ancestral appendages on the eighth and ninth segments. By articulating with each other and the surrounding abdominal sclerites, the valvifers allow the female to move the ovipositor valves in a coordinated fashion to deposit eggs.

148. (D) It consists of extensible, telescopic terminal abdominal segments rather than distinct valves
A substitute ovipositor, common in many flies and moths, differs from a true appendicular ovipositor by being formed from the terminal abdominal segments themselves. These segments are typically narrowed and highly extensible, allowing them to be telescoped out of the body to reach deep into substrates. This structure lacks the specialized appendicular valvulae and valvifers, relying instead on the flexibility of the posterior abdomen to guide the eggs.

149. (A) The appendicular ovipositor is modified into a venom-injecting sting and no longer transmits eggs
In stinging wasps, bees, and ants, the appendicular ovipositor has undergone a significant evolutionary modification. It has been transformed into a venom-injecting sting used primarily for defense and paralyzing prey. In these insects, the eggs are no longer transmitted through the sting shaft but instead exit the body from the base of the sting. This adaptation is central to the social and defensive behaviors of many Hymenoptera.

150. (C) Substitute ovipositor
Female fruit flies of the family Tephritidae possess a highly specialized, elongated structure at the end of the abdomen called an oviscape. This structure is a type of substitute ovipositor formed by the modification and extension of the posterior abdominal segments. It allows the fly to pierce the skin of fruits and deposit its eggs safely inside, where the larvae will have immediate access to food after hatching.

151. (A) Grasshoppers use stout valves to dig; cicadas use saw-like valves to cut plant tissue
While both grasshoppers and cicadas possess true appendicular ovipositors, their structures are functionally modified for different egg-laying sites. Grasshoppers have stout, blunt valves designed for digging holes in soil to deposit their egg pods. In contrast, cicadas have long, saw-like valves that are specialized for cutting slits into the tough tissues of twigs and branches, where their eggs will remain protected until they hatch.

152. (D) The ootheca in cockroaches is formed by the valvulae without secretion
Female genital structures perform several essential roles in reproduction. The gonopore is the exit for eggs, while the spermatheca stores sperm. Accessory glands often produce materials to glue eggs to surfaces. In cockroaches, the ootheca, or egg case, is not formed by the valvulae alone; it is created by the hardened

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secretions of the collateral glands that surround and protect the eggs as they are laid.

153. (B) Aedeagus
The aedeagus is the primary intromittent organ of male insects, used to transfer sperm or a spermatophore into the female reproductive tract during copulation. It is usually a sclerotized, tube-like structure that is part of the complex phallic organ. The morphology of the aedeagus is extremely diverse across different insect species and is a critical character used by taxonomists for accurate species identification and classification.

154. (C) Parameres
Parameres are paired, lateral sclerotized structures that form part of the external male genitalia. Their primary function is to act as claspers that grip and stabilize the female's abdomen during copulation. This mechanical connection ensures that the aedeagus can be accurately inserted into the female's genital opening. The shape and size of the parameres are often highly species-specific, reflecting the diverse mating strategies found in insects.

155. (D) Claspers maintain mechanical connection during copulation
In male insect genitalia, the various components work together to ensure successful sperm transfer. The aedeagus functions as the delivery organ, while the specialized claspers, derived from parameres or other abdominal sclerites, provide the mechanical force needed to maintain a secure connection with the female. This physical bond is crucial, as many insects mate while in motion or under environmental conditions that could otherwise disrupt the process.

156. (A) They often exhibit highly complex, species-specific morphology due to rapid sexual selection
The fine structural details of male external genitalia are invaluable for taxonomic identification because they often exhibit rapid and complex evolutionary changes. This diversity is primarily driven by sexual selection and reproductive competition, leading to unique, species-specific morphologies. Consequently, even closely related species that appear identical externally can often be distinguished by examining the precise shape and arrangement of their genital sclerites and aedeagus.

157. (B) 9th segment
The primary male genital structures are almost exclusively associated with the ninth abdominal segment, which is often referred to as the andrium. This segment is modified to support the phallic organ, including the aedeagus and the various clasping structures. While parts of the eighth or tenth segments may sometimes be involved, the ninth segment remains the fundamental structural center for the male reproductive apparatus in insects.

158. (B) Endophallus
The endophallus is the internal, membranous sac of the aedeagus that is everted during copulation. It often bears an array of specialized spines, hooks, or sclerotized plates known as titillators. These structures help to anchor the male genitalia within the female reproductive tract and can assist in the proper positioning of the spermatophore. The complex morphology of the endophallus is another key character used in advanced insect taxonomy.

159. (A) Males utilize one primary segment (9th), while females utilize two (8th and 9th)
Male and female insects differ in the number of abdominal segments primarily involved in their external genitalia. In males, the reproductive apparatus is largely centered on a single segment, the ninth. In contrast, the female appendicular ovipositor is a more complex structure that typically incorporates components from both the eighth and ninth segments. This difference reflects the distinct evolutionary origins and functional requirements of the male and female reproductive systems.

160. (C) Lock-and-key hypothesis
The lock-and-key hypothesis suggests that the complex and highly specific morphology of male and female genitalia serves as a mechanical reproductive isolation mechanism. This theory proposes that the unique structural compatibility between the genitalia of the same species prevents successful mating with individuals of different species. Such specificity is often driven by rapid evolution through sexual selection and reproductive competition.

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CHAPTER 03

Embryology, Internal Anatomy and Physiology

2013

1. Which of the following best describes the typical pattern of cleavage in the eggs of most higher insects?
(A) Meroblastic superficial cleavage
(B) Holoblastic unequal cleavage
(C) Meroblastic discoidal cleavage
(D) Holoblastic equal cleavage

2014

2. During the initial phases of insect embryonic development, what term is used to describe the migrating nucleus surrounded by a halo of cytoplasm prior to blastoderm formation?
(A) Blastocoele
(B) Oocyte
(C) Energid
(D) Trophocyte

2007

3. Which of the following statements regarding blastoderm formation in insects is INCORRECT?
(A) The cellular blastoderm is formed solely by the migration of pole cells.
(B) It begins when the migrating energids reach the periphery of the egg.
(C) A syncytial blastoderm precedes the formation of the cellular blastoderm.
(D) Cell membranes invaginate to separate individual nuclei during cellularization.

2016

4. Which of the following correctly pairs a region of the insect germ band with its eventual developmental fate?
(A) Protocorm – Develops exclusively into the reproductive organs
(B) Amnion – Develops into the midgut epithelium
(C) Serosa – Forms the primary nervous system network
(D) Protocephalon – Develops into the head appendages and brain

2007

5. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): Most insect eggs undergo meroblastic superficial cleavage rather than total cleavage.
Reason (R): The central mass of yolk in centrolecithal insect eggs completely prevents the fusion of male and female pronuclei.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2009

6. Consider the following statements regarding the phases of insect embryonic development:
I. Katatrepsis involves the movement of the embryo to its final position, usually with the head pointing toward the anterior pole.
II. The germ band invariably forms on the dorsal surface of the egg before migrating ventrally.
III. Anatrepsis is the initial movement of the embryo into the yolk mass.
Which of the above statements are correct?
(A) I and II
(B) I and III
(C) II
(D) III

2004

7. What is the primary physiological trigger for the initiation of blastokinesis in typical hemimetabolous insects?
(A) Total exhaustion of all available intracellular yolk proteins.
(B) Spontaneous rupture of the protective outer serosal cuticle.
(C) Gradual disintegration of the primary dorsal organ structure.
(D) Completion of body segmentation and

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appendage formation.

2024

8. The embryonic development of the insect tracheal system and salivary glands is primarily derived from which germ layer?
(A) Ectoderm
(B) Endoderm
(C) Mesoderm
(D) Mesenchyme

2004

9. Arrange the following events of insect gastrulation and early organogenesis in the correct developmental sequence:
I. Formation of the inner layer (mesoderm and endoderm)
II. Appearance of the primitive groove
III. Invagination of the median area of the germ band
IV. Differentiation of splanchnic and somatic mesoderm
(A) I, II, III, IV
(B) II, III, I, IV
(C) III, I, II, IV
(D) II, I, IV, III

2010

10. Which of the following structures is NOT a derivative of the embryonic mesoderm?
(A) Dorsal vessel
(B) Malpighian tubules
(C) Fat body tissue
(D) Skeletal muscles

2001

11. Which of the following statements correctly describes the origin of the midgut epithelium during embryonic organogenesis?
(A) It originates from the endoderm via the proliferation of mesenteron rudiments.
(B) It arises entirely from the lateral ectodermal invaginations during gastrulation.
(C) It is formed by the continuous inward growth of both stomodaeum and proctodaeum.
(D) It develops exclusively from the splanchnic mesoderm layer surrounding the yolk.

2017

12. The differentiation of the somatic musculature during organogenesis is primarily driven by:
(A) The direct invagination of the proctodaeal lining into the hemocoel.
(B) The outward expansion of the endodermal lining throughout the midgut.
(C) The differentiation of the somatic layer of the embryonic mesoderm.
(D) The lateral fusion of the stomodaeal cells during early organogenesis.

2023

13. How is the stomodaeum formally defined in the context of embryonic organogenesis?
(A) A mesodermal outpouching that forms the posterior hindgut structure.
(B) A secondary endodermal cavity that digests the remaining yolk mass.
(C) The initial furrow that defines the separation of head and thorax.
(D) An anterior ectodermal invagination that develops into the foregut.

2017

14. During the process of gastrulation in most insects, the true endoderm typically arises from:
(A) The extreme lateral margins of the ectodermal plates.
(B) The neural groove invagination along the ventral midline.
(C) The anterior and posterior poles of the invaginated layer.
(D) The lateral chordotonal bands formed during early growth.

2011

15. Match the following types of metamorphosis (List I) with their respective representative insect examples (List II):
List I: Types of Metamorphosis
P. Ametabolous
Q. Hemimetabolous
R. Holometabolous
S. Hypermetamorphosis
List II: Insect Examples
1. Neuroptera (Mantispidae)
2. Lepidoptera (Noctuidae)
3. Thysanura (Lepismatidae)
4. Odonata (Libellulidae)
(A) P-3, Q-4, R-2, S-1
(B) P-4, Q-3, R-1, S-2
(C) P-3, Q-1, R-4, S-2
(D) P-1, Q-2, R-3, S-4

2007

16. Which post-embryonic developmental strategy is most precisely characterized by the presence of distinctly different active and resting larval instars, such as a planidium first instar followed by a grub-like second instar?
(A) Hemimetabolous development
(B) Paurometabolous development

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(C) Ametabolous development
(D) Hypermetamorphosis

2009

17. When comparing hemimetabolous and holometabolous development, which physiological feature is unique to the holometabolous life cycle?
(A) Development of internal wings within imaginal discs.
(B) Regulation of the molting process by ecdysteroids.
(C) External development of wing pads in early instars.
(D) A distinct stage dedicated entirely to active feeding.

2023

18. Consider the following statements concerning post-embryonic growth phases:
I. Dyar's Law states that the linear dimensions of heavily sclerotized insect body parts increase by a constant ratio at each molt.
II. Przibram's Rule suggests that insect weight doubles during each successive instar.
III. Ametabolous insects continue to molt even after reaching sexual maturity.
IV. The pupal stage in holometabolous insects strictly feeds on specialized liquid diets.
Which of the above statements are correct?
(A) I and II
(B) I, III, IV
(C) I, II, III
(D) II, IV

2006

19. If an insect researcher observed a species that hatches from the egg resembling a miniature adult but lacking genitalia and wings, and continues to inhabit the same ecological niche as the adult, which development type can be immediately eliminated?
(A) Holometabolous
(B) Paurometabolous
(C) Hemimetabolous
(D) Ametabolous

2017

20. Based on ecological principles of post-embryonic development, what is the most significant evolutionary inference drawn from the holometabolous life cycle?
(A) It requires a longer total lifespan than ametabolous development.
(B) It prevents the need for hormonal regulation during larval stages.
(C) It significantly limits the dispersal capability of adult insects.
(D) It reduces intraspecific competition for food between life stages.

2011

21. In insect post-embryonic development, the term "imago" specifically defines:
(A) The active, feeding stage of a metamorphic or ametabolic lifecycle.
(B) The fully mature, typically winged and reproductively active adult.
(C) The transitional resting phase occurring inside a protective cocoon.
(D) The first instar larva emerging from the egg during initial hatching.

2008

22. Prothoracicotropic hormone (PTTH), a key regulator of insect molting, is synthesized primarily by neurosecretory cells located in the:
(A) Paed bodies known as the corpora allata.
(B) Storage organs known as the corpora cardiaca.
(C) Pars intercerebralis of the insect brain.
(D) Glandular tissue of the prothoracic gland.

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2003

23. A persistently high titer of Juvenile Hormone (JH) during an insect's early molting cycles directly causes:
(A) Premature metamorphosis into the finalized adult stage.
(B) The immediate initiation of pupation in late instars.
(C) Rapid degradation of the functional prothoracic gland.
(D) Retention of larval characteristics in the next instar.

2012

24. Select the correct physiological sequence of endocrine signaling that initiates insect molting:
(A) Brain releases Ecdysone → Prothoracic gland releases PTTH → Epidermis molts
(B) Corpora allata releases JH → Brain releases PTTH → Epidermis molts
(C) Brain releases PTTH → Prothoracic gland releases Ecdysone → Epidermis molts
(D) Prothoracic gland releases PTTH → Corpora cardiaca releases Ecdysone → Epidermis molts

2008

25. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): Ecdysis and the subsequent sclerotization of the new cuticle are distinct processes regulated by different hormones.
Reason (R): Eclosion hormone triggers ecdysis behaviors, whereas bursicon acts later to promote tanning and hardening of the cuticle.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2013

26. Which of the following is NOT a physiological action directly attributed to 20-hydroxyecdysone during the molting process?
(A) Inducing the epidermal cells to undergo apolysis.
(B) Maintaining activity of the corpora allata.
(C) Stimulating the secretion of a new epicuticle.
(D) Activating the production of molting fluid.

2010

27. Identify the correct pair regarding the primary site of synthesis for major developmental hormones in insects.
(A) Juvenile Hormone – Corpora allata
(B) Juvenile Hormone – Prothoracic gland
(C) Ecdysone – Corpora cardiaca
(D) Bursicon – Subesophageal ganglion exclusively

2012

28. Consider the following statements concerning the endocrine regulation of metamorphosis:
I. The corpora allata degenerate permanently just before the final larval molt in all holometabolous insects.
II. A high titer of ecdysteroids in the complete absence of juvenile hormone generally triggers the pupal-adult molt.
III. Eclosion hormone is primarily responsible for cuticular melanization.
IV. PTTH is released directly into the hemolymph via the corpora cardiaca or corpora allata depending on the insect order.
V. Juvenile hormone is an acyclic sesquiterpenoid derivative.
Which of the above statements are correct?
(A) I, II, III
(B) II, IV, V
(C) I, III, V
(D) II, III, IV, V

2011

29. What is a primary physiological advantage of an insect consuming its exuviae immediately after ecdysis?
(A) Reducing the concentration of circulating juvenile hormone.
(B) Recovering nutrients like amino acids and structural proteins.
(C) Accelerating the action of bursicon in the insect hemolymph.
(D) Aiding the mechanical expansion of the wings after emergence.

2023

30. Which of the following best defines the specific biological event known as "apolysis"?
(A) The physical shedding of the old epicuticle.
(B) Enzymatic digestion of the new endocuticle.
(C) Chemical cross-linking of cuticular proteins.
(D) Separation of the epidermis from the cuticle.

2009

31. Sclerotization is a critical post-ecdysial biochemical process defined strictly as:
(A) Degradation of chitin to N-acetylglucosamine.
(B) Synthesis of cement layer lipids by dermal glands.
(C) Cross-linking of proteins by quinones to stiffen.
(D) Targeted reabsorption of water from ecdysial space.

2007

32. In the molting cycle, the transitional state during which the insect has undergone apolysis and formed a new epicuticle but has not yet shed the old exuviae is termed the:
(A) Teneral stage
(B) Pharate stage
(C) Imago stage
(D) Prepupal stage

2012

33. What prevents the active molting fluid enzymes in the ecdysial space from digesting the newly forming cuticle underneath?
(A) Enzymes are highly specific and only target older, oxidized chitin molecules.
(B) The new cuticle is heavily cross-linked with quinones before digestion occurs.
(C) Epidermal cells continuously secrete basic buffers to neutralize active enzymes.
(D) The new cuticulin layer is chemically

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resistant and protects underlying layers.

2006

34. What structural adaptation facilitates the mechanical splitting of the old cuticle during ecdysis?
(A) Ecdysial lines, which lack the rigid xocuticular layer
(B) Tonofibrillae, which actively pull the cuticle apart
(C) Specialized pore canals that flood the surface with lipid solvents
(D) Endocuticular plates that expand under hemolymph pressure

2011

35. Identify the correct statement detailing the biochemical pathway of cuticular sclerotization.
(A) Tyrosine is directly polymerized into melanin without any intermediate steps.
(B) Sclerotization occurs entirely in the endocuticular layer following ecdysis.
(C) N-acetyldopamine (NADA) serves as a precursor for quinone cross-linking.
(D) Bursicon hormone inhibits the conversion of dopa molecules to dopamine.

2014

36. Which of the following statements about eruciform larvae is strictly INCORRECT?
(A) They lack any distinct body segmentation and appendages.
(B) They possess a well-developed head capsule and cylindrical body.
(C) They are equipped with both thoracic true legs and abdominal prolegs.
(D) They are typical of members of the order Lepidoptera.

2002

37. Based on structural adaptations, which morphological classification correctly describes a larva that is highly active, predatory, and possesses a prognathous head, long thoracic legs, and terminal abdominal cerci?
(A) Scarabaeiform
(B) Vermiform
(C) Platyform
(D) Campodeiform

2021

38. The complete absence of functional thoracic legs in apodous larvae (such as higher Diptera) is primarily a structural adaptation driven by:
(A) Development in aquatic environments requiring a more streamlined body shape.
(B) Eggs deposited directly onto or inside an abundant, localized food source.
(C) The biological necessity to migrate long distances through soil or wood.
(D) Loss of all neurosecretory activity during the embryonic organogenesis.

2005

39. Consider the following statements concerning scarabaeiform larvae:
I. They are commonly known as "white grubs."
II. They typically possess strong abdominal prolegs.
III. Their bodies are characteristically C-shaped and robust.
Which of the above statements are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II, III

2013

40. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): Campodeiform larvae are generally fast-moving and possess well-developed sensory organs compared to apodous larvae.
Reason (R): Campodeiform larvae are predominantly active predators that must actively search for, track, and capture mobile prey.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

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2019

41. An "oligopod" larva is defined formally by which morphological feature?
(A) Presence of thoracic legs and absence of functional abdominal prolegs.
(B) The presence of functional abdominal prolegs on the posterior segments.
(C) The total absence of all articulated thoracic and abdominal appendages.
(D) The presence of jointed legs on every body segment of the larval stage.

2017

42. Which of the following terms does NOT describe a recognized morphological type of insect larva?
(A) Elateriform
(B) Chrysalidiform

(C) Vermiform
(D) Eruciform

2002

43. Identify the correct pair that accurately matches a pupal type with an insect group that predominantly exhibits it.
(A) Coarctate pupa – Lepidoptera (Butterflies and moths)
(B) Exarate pupa – Hymenoptera (Bees and various wasps)
(C) Obtect pupa – Diptera (The suborder Cyclorrhapha)
(D) Decticous pupa – Coleoptera (Most typical beetles)

2016

44. Match the following morphological classifications of pupae (List I) with their primary identifying characteristic (List II):
List I: Pupal Classifications
P. Obtect
Q. Exarate
R. Coarctate
S. Decticous
List II: Identifying Characteristics
1. Appendages are entirely free and visible externally
2. Enclosed securely within the hardened exuviae of the final larval instar
3. Appendages are firmly glued to the body surface
4. Possesses articulated, functional mandibles used to chew out of the cocoon
(A) P-2, Q-3, R-1, S-4
(B) P-3, Q-1, R-4, S-2
(C) P-3, Q-1, R-2, S-4
(D) P-1, Q-4, R-2, S-3

2014

45. In a structural comparison of pupal forms, the principal distinction between decticous and adecticous pupae lies in:
(A) The presence or absence of a silk cocoon
(B) The developmental origin of the compound eye
(C) The mobility and function of the pupal mandibles
(D) The degree to which the wings are glued to the thorax

2009

46. The hardened outer casing of a coarctate pupa, formed from the final larval skin, is technically termed the:
(A) Cocoon
(B) Chrysalis
(C) Exuvium
(D) Puparium

2013

47. Which structural feature is highly characteristic of an obtect pupa?
(A) Free-moving legs and antennae capable of performing defensive strikes.
(B) Complete enclosure inside a soil-based cell without any silk lining.
(C) Sclerotized exterior with appendages fused immovably to the body.
(D) Functional wings that allow limited gliding before the adult emerges.

2005

48. The term "chrysalis" is primarily a specific recall term used to describe the typically exposed, often geometrically intricate pupa of which insect group?
(A) Moths (various)
(B) Butterflies
(C) Common beetles
(D) Social wasps

2015

49. What is the primary evolutionary advantage associated with the development of the coarctate pupal form?
(A) The ability to feed continually throughout the pupal resting stage.
(B) Increased mobility allowing relocate to optimal microclimates.
(C) Rapid internal heat generation through the thick puparium wall.
(D) Protection from predators provided by the retained larval cuticle.

2019

50. Which is the most appropriate description of the primary physiological role of the proctodaeum in the insect alimentary canal?
(A) Excretion of uric acid and intensive reabsorption of water and salts.
(B) Initial mechanical grinding and lubrication of ingested food particles.
(C) Secretion of principal digestive enzymes and absorption of simple sugars.
(D) Storage of ingested food materials prior to passage into the midgut.

2004

51. When analyzing the embryological origin of the alimentary canal sections, which layer can

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be eliminated as the primary source of the mesenteron?
(A) Mesoderm
(B) Endoderm
(C) Ectoderm
(D) Neural crest cells

2002

52. Consider the following statements regarding the stomodaeum:
I. It is embryologically derived from the ectoderm.
II. It possesses a cuticular intima.
III. The proventriculus is located at its posterior end.
Which of the above statements are correct?
(A) I and III
(B) II
(C) I
(D) II and III

2001

53. The cuticular lining that protects the epithelial cells of the foregut and hindgut from mechanical abrasion is technically defined as the:
(A) Peritrophic matrix
(B) Basement membrane
(C) Striated border
(D) Intima

2014

54. Conceptually, why does the insect foregut possess a structural cuticular lining while the midgut typically does not?
(A) The foregut requires flexibility for breathing, whereas the midgut must remain rigid.
(B) The midgut epithelium is specialized for enzyme secretion, which a cuticle hinders.
(C) The foregut is exposed to lower internal hemolymph pressures than the midgut region.
(D) The cuticular lining in the foregut actively synthesizes all digestive proteases.

2021

55. Based on the embryological origin of the midgut, what can be inferred about its behavior during an insect's typical molting cycle (ecdysis)?
(A) The midgut epithelium is shed along with the outer exoskeleton.
(B) The midgut expands rapidly due to accumulation of exuvial fluid.
(C) The midgut does not shed a cuticle as it is an endodermal derivative.
(D) The entire midgut regenerates from the stomodaeal valve structure.

2023

56. What functional requirement causes the epithelial cells of the hindgut (rectum) in desert insects to possess heavily folded apical membranes associated with numerous mitochondria?
(A) The requirement to synthesize and secrete massive amounts of chitinase.
(B) The need for rapid mechanical digestion of tough structural plant fibers.
(C) The necessity to rapidly pump hemolymph into the anterior dorsal vessel.
(D) The active transport required for water conservation against gradients.

2023

57. The peritrophic membrane in the insect midgut is primarily composed of:
(A) Chitin microfibrils in a protein-carbohydrate matrix.
(B) Pure cellulose and various hemicellulose fibers.
(C) Saturated lipids, sterols, and heavy wax esters.
(D) Glycogen and highly branched structural starches.

2006

58. Identify the correct pair linking a specialized digestive mechanism with its appropriate functional description in sap-feeding insects.
(A) Peritrophic membrane – Physical grinding of solid plant material.
(B) Filter chamber – Direct shunting of excess water to the hindgut.
(C) Proventriculus – Secretion of strong alkaline buffers into the gut.
(D) Gastric caeca – Excretion of nitrogenous wastes into the hemolymph.

2011

59. Type I peritrophic membrane is factually characterized by:
(A) Being delaminated continuously from the entire length of the midgut epithelium.
(B) Being produced by a specialized ring of cells at the stomodaeal valve.
(C) Lacking chitin entirely and being composed only of acidic mucopolysaccharides.
(D) Being highly impermeable to all digestive enzymes to protect the midgut cells.

2016

60. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).

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Assertion (A): In many Hemipteran insects (true bugs), a distinct peritrophic membrane is absent.
Reason (R): Hemipterans primarily feed on liquid diets (plant sap or blood), eliminating the need for a structure that primarily protects the midgut from mechanical abrasion by solid food.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2014

61. The "filter chamber" in homopterans (e.g., aphids, cicadas) is defined functionally as:
(A) A specialized network of tracheoles that filters out airborne pathogens.
(B) A dense concentration of setae in the pharynx that prevents large particles.
(C) Anatomical modification to bypass water and concentrate nutrients.
(D) A section of the malpighian tubules responsible for filtering out toxins.

2021

62. Which of the following substances is generally NOT significantly digested or absorbed in the anterior foregut (crop) of most insects?
(A) Simple glucose and fructose sugars.
(B) Complex carbohydrates digested by amylase.
(C) Small, soluble lipid molecules.
(D) Large proteins requiring proteases.

2025

63. The primary enzyme responsible for breaking down the principal hemolymph sugar in insects to meet rapid energy demands is:
(A) Invertase
(B) Lipase
(C) Trehalase
(D) Cellulase

2025

64. Which distinct functional classification of hemocytes is primarily responsible for the rapid, active phagocytosis of small foreign particles, such as bacteria, within the insect hemocoel?
(A) Oenocytoids
(B) Plasmatocytes
(C) Prohemocytes
(D) Spherulocytes

2019

65. Consider the following statements concerning the properties and functions of insect hemolymph:
I. Hemolymph acts as a hydraulic medium, essential for structural expansion during ecdysis.
II. Hemolymph strictly maintains a neutral pH under all physiological conditions.
III. Hemolymph transports nutrients, hormones, and metabolic wastes.
IV. The primary respiratory function of hemolymph relies on dissolved hemoglobin in most species.
Which of the above statements are correct?
(A) I and III
(B) I, II, and IV
(C) II and III
(D) I and II

2006

66. During the cellular immune response, if a foreign body is too large to be phagocytosed by single plasmatocytes (e.g., a parasitoid wasp egg), what conceptual mechanism is employed by the hemocytes?
(A) They initiate nodulation or form a capsule around the invader.
(B) They secrete heavy concentrations of amylases into the hemolymph.
(C) They undergo rapid apoptosis to release defensive cytotoxic quinones.
(D) They physically block the spiracles nearest the invader to suffocate.

2010

67. The defining feature of trehalose, the primary sugar found in insect hemolymph, is that it is a:
(A) A highly reducing monosaccharide energy source.
(B) A complex structural polysaccharide of the wall.
(C) A non-reducing disaccharide of two glucose units.
(D) A sugar alcohol utilized for freezing tolerance.

2018

68. The stem cells or progenitor cells circulating in the hemolymph that divide and differentiate into other specific hemocyte types are known as:
(A) Prohemocytes
(B) Adipohemocytes
(C) Granulocytes
(D) Oenocytoids

2019

69. Because insect hemolymph generally lacks hemoglobin or other efficient oxygen-carrying

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pigments, which physiological system assumes almost the entire burden of gas exchange?
(A) The integumentary glandular system
(B) The specialized respiratory crypts in the malpighian tubules
(C) The highly vascularized crop and midgut
(D) The extensive network of the tracheal system

2005

70. Identify the correct statement regarding the role of oenocytoids in insect immunity.
(A) They are the primary cells that ingest and digest circulating bacteria.
(B) They store and release prophenoloxidase for the melanization cascade.
(C) They physically aggregate to form the initial plug during wound healing.
(D) They store vast amounts of lipids required for energy during prolonged periods.

2023

71. The open body cavity through which hemolymph freely circulates in insects is formally defined as the:
(A) Coelom
(B) Pseudocoelom
(C) Hemocoel
(D) Blastocoel

2015

72. Factually, the pumping action of the dorsal vessel is mechanically assisted by thin, fan-shaped sheets of muscle connected to the terga, known as:
(A) Longitudinal sternal muscles
(B) Dorso-ventral indirect muscles
(C) Pleural intersegmental muscles
(D) Alary muscles

2004

73. What is the primary cause that dictates the generally unidirectional, posterior-to-anterior flow of hemolymph within the insect dorsal vessel?
(A) Rhythmic heart contractions and valves that prevent backflow.
(B) Osmotic gradient established by malpighian tubules in abdomen.
(C) Negative pressure generated by ventilation of thoracic spiracles.
(D) High concentration of hemocytes pulling fluid toward the brain.

2023

74. The valve-like lateral openings on the heart segment of the dorsal vessel, through which hemolymph enters from the pericardial sinus, are called:
(A) Spiracles
(B) Ostia
(C) Taenidia
(D) Crypts

2007

75. Which of the following statements about accessory pulsatile organs in insects is INCORRECT?
(A) They are composed of dense networks of tracheal tubes rather than muscle.
(B) They generate pressure to force hemolymph into narrow appendages.
(C) They are located at the bases of the antennae, wings, and leg segments.
(D) They function semi-autonomously to maintain localized fluid circulation.

2011

76. When comparing the open circulatory system of an insect to the closed circulatory system of a vertebrate, which distinguishing feature is fundamentally absent in the insect model?
(A) A network of capillaries bridging arteries and veins.
(B) A dedicated tubular organ capable of muscular contraction.
(C) Circulating fluid that transports nutrients and wastes.
(D) Specialized cells functioning in cellular immunity.

2010

77. Conceptually, why must the terminal ends of the tracheoles be fluid-filled during periods of rest but become air-filled during strenuous activity?
(A) The fluid dissolves structural cuticular proteins when muscles are active.
(B) Rapid muscle contraction mechanically squeezes the fluid back into the blood.
(C) Increased osmotic pressure in muscle cells draws fluid out for gas diffusion.
(D) The fluid physically turns to gas when internal body temperature rises high.

2025

78. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): Tracheal tubes are reinforced by spiral cuticular thickenings called taenidia.
Reason (R): Taenidia prevent the tracheae from collapsing under changes in internal body pressure while maintaining longitudinal flexibility.
(A) Both A and R are true but R is not the

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correct explanation of A.
(B) Both A and R are true and R is the correct explanation of A.
(C) A is false but R is true.
(D) A is true but R is false.

2018

79. Consider the following statements regarding spiracle types and ventilation:
I. Holopneustic insects typically possess 10 pairs of functional spiracles.
II. Apneustic insects lack functional open spiracles entirely and rely on cutaneous gas exchange or gills.
III. Metapneustic respiratory systems have only the last abdominal pair of spiracles functional.
IV. Propneustic insects use only the prothoracic spiracles for breathing.
V. Active ventilation in large insects is driven by rhythmic abdominal contractions.
Which of the above statements are correct?
(A) I and II
(B) I, II, V
(C) III and IV
(D) II, III, IV

2025

80. Factually, the invaginated chamber immediately inside a spiracle, which often contains filtering setae or a valved closing mechanism, is called the:
(A) Tracheole cell
(B) Atrium
(C) Peristigmatic gland
(D) Ostium

2016

81. In which of the following specialized habitats would an insect most likely rely on an apneustic respiratory adaptation (complete loss of open spiracles)?
(A) A mature forest canopy environment.
(B) A dry, sandy desert dune environment.
(C) Inside a hollow, ventilated plant stem.
(D) A submerged benthic aquatic environment.

2017

82. Identify the correct pair associating a mechanism of insect respiratory ventilation with its primary physical driver.
(A) Autoventilation – Flight muscles compressing thoracic air sacs.
(B) Passive diffusion – Muscular contraction of the tergosternal muscles.
(C) Discontinuous Gas Exchange – Rapid panting of the abdomen for water.
(D) Plastron respiration – Pumping of hemolymph into the tracheal trunks.

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2023

83. What is the primary physiological advantage of possessing a plastron (an incompressible physical gill) for an aquatic insect?
(A) It allows the insect to store a massive, compressible bubble of oxygen.
(B) It heavily increases the specific gravity, preventing it from floating.
(C) It acts as a permanent gill that never needs to be replenished at surface.
(D) It mechanically filters toxic heavy metals before they enter the spiracles.

2015

84. How is a standard "compressible physical gill" in diving beetles accurately defined?
(A) Bubble carried externally that shrinks as oxygen is consumed.
(B) Dense mat of hydrophobic hairs that traps a thin layer of gas.
(C) Rigid cuticular extension that absorbs oxygen via direct osmosis.
(D) Specialized hemolymph sac that stores oxygen bound to proteins.

2017

85. What is the primary cause that allows certain endoparasitic insect larvae (like some Tachinidae) to effectively respire while completely submerged within the host's hemocoel?
(A) They absorb dissolved oxygen continuously across a highly permeable cuticle.
(B) They actively parasitize and merge with the host's central nervous system.
(C) They possess highly efficient anaerobic metabolic pathways requiring none.
(D) They tap into host tracheal trunks or maintain a connection to outside.

2009

86. Tracheal gills, commonly found in the nymphs of Ephemeroptera (mayflies) and Odonata (damselflies), are strictly located in which body regions respectively?
(A) Mayflies: Thoracic sterna; Damselflies: Caudal (terminal).
(B) Mayflies: Lateral margins; Damselflies: Caudal (terminal).
(C) Mayflies: Inside the hindgut; Damselflies: Lateral margins.

(D) Mayflies: Head capsule; Damselflies: Thoracic pleura region.

2023

87. Conceptually, why does a compressible air bubble act as an oxygen gill rather than just a simple finite oxygen store?
(A) The bubble directly synthesizes oxygen via a symbiotic relationship.
(B) As nitrogen diffuses into the water, it chemically forces water split.
(C) Consumed oxygen lowers partial pressure, causing diffusion into bubble.
(D) The insect's spiracles pump carbon dioxide out, displacing the oxygen.

2019

88. Match the respiratory adaptation (List I) with the correct description or organism (List II):
List I: Respiratory Adaptation
P. Rectal tracheal gills
Q. Plastron
R. Siphon tube
S. Blood gills (minimal tracheation)
List II: Description or Organism
1. Larvae of Chironomidae (bloodworms)
2. Nymphs of Anisoptera (dragonflies)
3. Aquatic Hemiptera (e.g., Aphelocheirus)
4. Larvae of Culicidae (mosquitoes)
(A) P-2, Q-4, R-1, S-3
(B) P-3, Q-1, R-4, S-2
(C) P-1, Q-3, R-2, S-4
(D) P-2, Q-3, R-4, S-1

2011

89. Identify the correct statement regarding the morphological structure of a typical insect ovariole.
(A) Germarium contains developing oocytes and pre-follicular tissue.
(B) Vitellarium is located anterior to germarium where mitosis occurs.
(C) Terminal filament anchors the anterior tip of ovariole to midgut.
(D) Pedicel is the zone of maturation and heavy yolk deposition tasks.

2006

90. Factually, what is the specific biological function of the spermatheca in the female insect reproductive system?
(A) Chamber where fertilization strictly occurs during copulation.
(B) Stores and maintains the viability of received spermatozoa.
(C) Synthesizes the chorion around the mature developing oocyte.
(D) Secretes juvenile hormone to stimulate vitellogenesis cycles.

2009

91. Which of the following organs in the male insect reproductive system is primarily responsible for secreting the seminal fluid and producing the structural components of the spermatophore?
(A) Male accessory glands (MAGs).
(B) Testicular follicles of the testes.
(C) Vasa deferentia transport tubes.
(D) The ejaculatory duct structures.

2014

92. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): Vitellogenesis requires the active transport of large protein precursors (vitellogenins) from the hemolymph into the developing oocyte.
Reason (R): Vitellogenins are synthesized entirely by the follicular epithelial cells surrounding the oocyte.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2001

93. Based on the anatomical organization of an ovariole, what can be logically inferred if an insect possesses panoistic ovarioles rather than meroistic ones?
(A) The insect must have an exceptionally rapid rate of reproduction.
(B) Oocytes are nourished by specialized trophocytes in the follicle.
(C) Oocytes rely on the follicular epithelium, lacking trophocytes.
(D) The ovaries completely lack a germarium and terminal filaments.

2018

94. The specific region of the female reproductive tract where the mature egg receives its final protective coating or is glued to a substrate via secretions is associated with the:
(A) The calyx region
(B) Lateral oviducts
(C) The germarium
(D) Accessory glands

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2001

95. In comparing atypical modes of insect reproduction, what is the defining difference between arrhenotoky and thelytoky?
(A) Arrhenotoky requires mating, whereas thelytoky occurs without it.
(B) Arrhenotoky results in polymorphic, sterile worker offspring.
(C) Arrhenotoky results in males, while thelytoky results in females.
(D) Arrhenotoky is a form of viviparity, while thelytoky is oviparity.

2004

96. Polyembryony, as observed in certain endoparasitic Hymenoptera, conceptually serves to:
(A) Maximize the nutritional value of a single egg laid in the soil.
(B) Produce hundreds of identical offspring from one fertilized egg.
(C) Ensure the survival of the mother during the process of oviposition.
(D) Prevent host recognition by masking its specific genetic signature.

2014

97. Arrange the generalized sequence of a paedogenetic life cycle (e.g., in the gall midge Miastor):
I. Parthenogenetic development of embryos within the larval hemocoel
II. Hatching of the mother larva from the egg
III. Internal consumption of the mother larva's tissues by the developing offspring
IV. Emergence of the daughter larvae from the mother's carcass
(A) I, II, III, IV
(B) II, I, IV, III
(C) II, I, III, IV
(D) I, III, II, IV

2016

98. What physiological condition causes pseudoplacental viviparity to differ distinctly from strictly ovoviviparous reproduction in insects?
(A) Embryo derives nourishment from tissues via a placenta structure.
(B) Egg develops internally relying solely on its internal yolk mass.
(C) Mother provides milk-like secretions to larva in a uterine pouch.
(D) Offspring emerge as fully formed pupae rather than larval stages.

2001

99. The specialized mode of reproduction seen in the tsetse fly (Glossinidae), where a single larva develops within the female's uterus and feeds on secretions from specialized milk glands until it is ready to pupate immediately upon birth, is definitively called:
(A) Ovoviviparity
(B) Hemocoelous viviparity
(C) Adenotrophic viviparity
(D) Paedogenesis

2016

100. Factually, cyclical parthenogenesis (heteroecy), where an insect alternates between asexual and seasonal reproductive phases depending heavily on seasonal changes, is a hallmark reproductive strategy of:
(A) Aphids (Aphididae)
(B) Blowflies (Calliphoridae)
(C) Honey bees (Apidae)
(D) Stick insects (Phasmatodea)

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2011

101. Which of the following anatomical structures is NOT a component of the insect Visceral (Stomatogastric) Nervous System?
(A) Frontal ganglion
(B) Hypocerebral ganglion
(C) Recurrent nerve
(D) Prothoracic ganglion

2025

102. Consider the following statements concerning the Central Nervous System (CNS) of insects:
I. The brain (supraesophageal ganglion) consists of three fused ganglia: protocerebrum, deutocerebrum, and tritocerebrum.
II. The ventral nerve cord invariably contains exactly three distinct thoracic ganglia and exactly eight strictly unfused abdominal ganglia in all adult insects.
III. The subesophageal ganglion innervates the mandibles, maxillae, and labium.
Which of the above statements are correct?
(A) I and II
(B) II
(C) I and III
(D) III

2023

103. The protocerebrum, the largest and most complex region of the insect brain, is primarily responsible for innervating and processing information from the:
(A) The antennae

(B) The mouthparts
(C) Compound eyes
(D) The foregut

2016

104. Factually, what is the primary physiological function governed by the stomatogastric nervous system?
(A) Coordination of rapid escape reflexes in the abdominal cerci.
(B) Control of the direct and indirect flight muscles in thorax.
(C) Reception of auditory signals from the various tympanic organs.
(D) Regulation of movements and processes of the anterior foregut.

2010

105. Identify the correct pair associating a specific brain lobe with its primary structural and functional feature.
(A) Deutocerebrum – Processes olfactory input from the antennae.
(B) Protocerebrum – Primary innervation of the antennal segments.
(C) Tritocerebrum – Contains optic lobes for visual processing.
(D) Subesophageal ganglion – Processes visual orientation signals.

2019

106. Which is the most appropriate description of the generalized architecture of the insect ventral nerve cord?
(A) Single, unsegmented spinal cord situated dorsal to the digestive tract.
(B) A chain of segmentally arranged ganglia located ventrally below the gut.
(C) A diffuse, uncentralized net of neurons scattered throughout the hemocoel.
(D) A strictly fused mass located within the mesothorax of the adult insect.

2017

107. When analyzing the generation of an axonal impulse (action potential) in an insect neuron, which physiological event can be eliminated as a contributing factor to the rapid depolarization phase?
(A) The rapid opening of voltage-gated sodium channels
(B) The massive influx of sodium ions down their electrochemical gradient
(C) The rapid influx of large, negatively charged intracellular proteins
(D) A transient reversal of the resting membrane potential across the axolemma

2012

108. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): Acetylcholinesterase inhibitors are highly effective and common neurotoxic insecticides.
Reason (R): Inhibiting acetylcholinesterase prevents the breakdown of acetylcholine in the synaptic cleft, causing continuous, uncontrolled firing of the post-synaptic neuron.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2015

109. In the insect central nervous system, Gamma-aminobutyric acid (GABA) primarily functions factually as:
(A) The main excitatory neurotransmitter at the neuromuscular junction
(B) A hormone regulating lipid mobilization from the fat body
(C) The principal inhibitory neurotransmitter
(D) A specialized neurohormone for molting initiation

2012

110. Consider the following statements regarding synaptic transmission in insects:
I. Synaptic transmission is typically unidirectional, traveling from the pre-synaptic to the post-synaptic neuron.
II. Neurotransmitters are stored in vesicles within the pre-synaptic terminal.
III. The arrival of an action potential triggers the influx of Calcium ($Ca^{\{2+\}}$) ions, which facilitates vesicle fusion.
IV. Synaptic clefts physically connect the cytoplasm of adjacent neurons to allow rapid ion exchange without transmitters.
Which of the above statements are correct?
(A) I, II, III, IV
(B) I, II, III
(C) I, III, IV
(D) II, IV

2022

111. Conceptually, what guarantees the swift termination of a chemical signal at a typical

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insect cholinergic synapse, preventing continuous stimulation?

(A) Diffusion of the neurotransmitter followed by slow renal excretion.
(B) Active reuptake of the intact transmitter for subsequent energy use.
(C) Enzymatic hydrolysis of the neurotransmitter within the synapse.
(D) Immediate reversal of the action potential polarity closing the receptors.

2022

112. Why is saltatory conduction entirely absent in insect nervous systems?

(A) Insect nervous systems rely on graded potentials rather than action potentials.
(B) Insect axons are unmyelinated, lacking lipid-rich sheaths and nodes of Ranvier.
(C) The hemolymph surrounding the nerve cord blocks all rapid electrical jumping.
(D) Insect neurons use only chemical, not electrical, gradients to propagate signal.

2015

113. What environmental or ecological pressure is the primary cause for the evolutionary development of the cryptonephric arrangement of Malpighian tubules?

(A) A need to rapidly expel large volumes of dilute urine in aquatic environments.
(B) The requirement to filter massive, complex protein toxins from the midgut.
(C) The evolutionary shift to an exclusively liquid, sap-based diet for waste.
(D) An extreme necessity to conserve water in intensely dry, arid environments.

2006

114. Arrange the general sequence of events in the primary excretory pathway of a typical terrestrial insect:

I. Active transport of Potassium (K^+) or Sodium (Na^+) into the lumen of the Malpighian tubule
II. Osmotic flow of water and passive diffusion of soluble wastes (e.g., uric acid) into the tubule lumen
III. Selective reabsorption of water, essential ions, and metabolites in the rectum
IV. Excretion of concentrated, semi-solid feces/urine mixture via the anus

(A) II, I, III, IV
(B) I, III, II, IV
(C) III, I, II, IV
(D) I, II, III, IV

NODIA

2017

115. In a structural comparison, Malpighian tubules differ fundamentally from the midgut because the Malpighian tubules:

(A) Are derived primarily from the ectoderm and generally lack a cuticular intima.
(B) Are highly tracheated and actively perform respiration instead of excretion.
(C) Originate from the ectoderm (proctodaeum) rather than the endoderm.
(D) Are attached entirely to the stomodaeal valve rather than the pyloric sphincter.

2024

116. Factually, the "primary urine" initially secreted into the distal ends of the Malpighian tubules is best characterized as:

(A) Isosmotic fluid with water, ions, and organic molecules.
(B) Highly hyperosmotic, consisting mostly of uric acid.
(C) Strongly hypotonic, containing almost pure water only.
(D) Thick, lipid-rich fluid devoid of nitrogenous waste.

2008

117. Match the Malpighian tubule characteristic (List I) with its defining trait or functional description (List II):

List I: Malpighian Tubule Characteristics
P. Cryptonephric system
Q. Diuresis
R. Uric acid
S. Ammonotelism

List II: Traits or Functional Descriptions
1. Primary nitrogenous waste of most aquatic insects, highly toxic but water-soluble.
2. Primary nitrogenous waste of terrestrial insects, heavily synthesized for water conservation.
3. Rapid secretion of large volumes of fluid, often triggered after a massive blood meal.
4. Distal ends of the tubules are closely bound to the rectum within a perinephric membrane.

(A) P-4, Q-3, R-2, S-1
(B) P-3, Q-4, R-1, S-2
(C) P-1, Q-2, R-4, S-3
(D) P-2, Q-1, R-3, S-4

2017

118. Which specific cellular mechanism primarily drives the formation of fluid in the typical insect Malpighian tubule?

(A) Ultrafiltration driven strictly by high hemolymph hydrostatic pressure from heart.
(B) Active transport of cations (K^+ or Na^+) creating a strong osmotic gradient.
(C) Active, ATP-dependent transport of various heavy metals into the tubule lumen.
(D) Passive diffusion of large storage proteins down a steep concentration gradient.

2008

119. What is the supreme physiological advantage of uricotelism (excreting uric acid) for terrestrial insects compared to excreting urea or ammonia?
(A) Uric acid is extremely soluble in water, allowing it to be flushed out instantly.
(B) Uric acid physically protects the hindgut lining from mechanical abrasion damage.
(C) Uric acid is insoluble and non-toxic, allowing excretion as dry paste for water.
(D) Uric acid demands virtually no metabolic energy to synthesize in active tissues.

2015

120. How is ammonotelism specifically defined in the context of insect biochemistry?
(A) The synthesis of ammonia as a precursor to heavy cuticle melanization.
(B) The metabolic storage of ammonia in the fat body as a reserve nutrient.
(C) The conversion of toxic ammonia strictly into inert urea for storage.
(D) The direct excretion of nitrogenous waste primarily as soluble ammonia.

2019

121. In some insect orders (such as Diptera and Lepidoptera), uric acid is further degraded enzymatically before excretion. Factually, the primary products of this specialized purine degradation pathway are:
(A) Allantoin and allantoic acid
(B) Ammonia and carbon dioxide
(C) Urea and elemental nitrogen
(D) Guanine and creatinine

2017

122. Which of the following statements regarding the hormonal control of osmoregulation in insects is INCORRECT?
(A) Diuretic hormones (DH) stimulate tubules to increase secretion.
(B) Antidiuretic hormones act on the rectum to increase reabsorption.
(C) Neurosecretory cells in the brain are sources of these hormones.
(D) Diuretic hormones halt ion transport to instantly conserve water.

2012

123. Conceptually, the prominent structural features known as "rectal pads" or "rectal papillae" are highly optimized for:
(A) Creating massive osmotic gradients to extract water from feces.
(B) Pumping respiratory gases into hindgut to support digestion.
(C) Generating muscular contractions to forcibly eject body waste.
(D) Absorbing heavy structural lipids that slipped past the gut.

2007

124. Identify the correct statement regarding the toxicity and required dilution of different nitrogenous wastes.
(A) Ammonia is toxic and requires immense volumes of water for excretion.
(B) Uric acid requires the largest volume of water for safe excretion cycle.
(C) Ammonia is virtually non-toxic and can be stored indefinitely in blood.
(D) Urea is the standard metabolic waste as it requires zero metabolic steps.

2008

125. Based on the structural mechanisms of ommatidia, what can be fundamentally inferred about an insect possessing exclusively superposition eyes rather than apposition eyes?
(A) It is active strictly during bright daylight and requires high acuity.
(B) It lacks any pigment cells, rendering the entire eye structure clear.
(C) It is likely nocturnal, sacrificing sharp resolution to gather light.
(D) It possesses compound eyes incapable of forming any focused image.

2008

126. Factually, a single functional visual unit of an insect's compound eye is called an ommatidium. Which structural components form its dioptric (light-gathering) apparatus?
(A) The rhabdomeres and retinula cells
(B) The basement membrane and optic nerve
(C) The primary pigment cells and basal pigment cells
(D) The corneal lens and crystalline cone

NODIA

2021

127. In the ommatidium, the specialized sensory neurons that actually contain the photopigments and convert light energy into an electrical signal are defined as the:
(A) Semper cells
(B) Corneagen cells
(C) Retinula cells
(D) Secondary pigment cells

2013

128. The central rod-like structure formed by the inner microvillar edges of the retinula cells, which houses the visual pigment rhodopsin, is recalled strictly as the:
(A) Cone stalk
(B) Rhabdom
(C) Crystalline tract
(D) Tapetum

2008

129. Identify the correct pair associating an insect visual organ with its primary accepted function.
(A) Compound eye – Exclusive detection of polarized light only.
(B) Stemmata – High-resolution vision in adult insect species.
(C) Rhabdomere – Secretion of the external corneal cuticular lens.
(D) Dorsal ocelli – Sensitivity to light changes for flight stability.

2025

130. When comparing the pigment migration within the compound eyes of certain insects, what happens during adaptation to dark environments in superposition eyes?
(A) Pigment granules migrate upward to allow light rays to cross over.
(B) Pigment surrounds the crystalline cone, isolating each ommatidium.
(C) Retinula cells retract below the basement membrane to avoid damage.
(D) Cornea mechanically thickens to focus faint light more sharply now.

2003

131. Match the specific type of mechanoreceptor (List I) with its characteristic anatomical description (List II):
List I: Types of Mechanoreceptor
P. Trichoid sensilla
Q. Campaniform sensilla
R. Chordotonal organs
S. Tympanum
List II: Anatomical Descriptions
1. Internal sensory receptors stretched between two points on the body wall, lacking an external cuticular structure.
2. A specialized, thin cuticular membrane linked internally to chordotonal sensilla, optimized for detecting sound waves.
3. Hair-like external setae that articulate in a membranous socket, primarily detecting tactile stimuli.
4. Dome-shaped cuticular stress receptors located in areas subject to mechanical distortion (e.g., wing bases).
(A) P-2, Q-4, R-1, S-3
(B) P-3, Q-1, R-4, S-2
(C) P-1, Q-2, R-3, S-4
(D) P-3, Q-4, R-1, S-2

2018

132. What is the primary physical cause that enables a tympanal organ to function as a highly effective auditory receptor?
(A) It consists of a thin membrane linked internally to chordotonal sensilla.
(B) The tympanum is a rigidly thick piece of cuticle that deeply resonates.
(C) It is heavily coated in dense, viscous fluids that trap sound particles.
(D) It actively emits ultrasonic pulses and measures the exact echo return.

2015

133. How is Johnston's organ correctly defined in terms of its specific location and function?
(A) An olfactory receptor complex located exclusively on the maxillary palps.
(B) A heavy mechanoreceptor pad situated strictly on the tarsi for vibration.
(C) A gravity-detecting statocyst located in the halteres of various Diptera.
(D) A specialized chordotonal organ located within the antennal pedicel.

2003

134. Conceptually, when a trichoid sensillum is physically deflected by touch or air currents, the mechanical deformation directly triggers:
(A) A massive release of ecdysone from the specific socket cell region.
(B) The opening of stretch-activated ion channels in the sensory neuron.
(C) Immediate apoptosis of the trichogen cell following the deflection.
(D) Physical splitting of the cuticular hair to release all pheromones.

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2023

135. Factually, the basic functional sensory unit of any internal chordotonal organ, consisting minimally of a bipolar neuron, a scolopale cell, and an attachment cell, is explicitly called a:
(A) Campaniform dome
(B) Sensillum lymph
(C) Scolopidium
(D) Ommatidium

2023

136. Which of the following sensory concepts does NOT generally apply to proprioceptors?
(A) They provide the central nervous system with continuous information about the relative positions of body parts.
(B) They monitor the degree of stretch in skeletal muscles and the digestive tract.
(C) Hair plates located at the articulated joints heavily function as proprioceptors.
(D) They are exclusively external, long, filamentous hairs completely exposed to the open environment.

2008

137. Factually, typical olfactory sensilla located on the insect antennae differ fundamentally from most tactile mechanoreceptors because the cuticular wall of an olfactory sensillum:
(A) Is perforated by numerous microscopic pores to allow molecules to enter.
(B) Is completely solid and impenetrable, requiring the odor to dissolve.
(C) Is heavily articulated at the base to sweep actively through the air.
(D) Contains a large air sac connected directly to the tracheal system.

2021

138. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): Gustatory (contact chemoreceptor) sensilla generally possess a single distinct pore located at the very tip of the hair (uniporous).
Reason (R): Gustatory sensilla typically lack a mechanosensory neuron, relying exclusively on multiple chemosensory dendrites.
(A) Both A and R are true and R is the correct explanation of A.
(B) A is true but R is false.
(C) A is false but R is true.
(D) Both A and R are false.

2025

139. Identify the correct pair associating a specific chemosensory function with its most typical location on the insect body.
(A) Long-range Olfaction (Smell) – Tympanum on the first abdominal segment
(B) Contact chemoreception (Taste) – Tarsi of the forelegs and mouthparts
(C) Contact chemoreception (Taste) – Compound eyes and ocelli
(D) Long-range Olfaction (Smell) – Direct surface of the midgut epithelium

2019

140. How are Odorant Binding Proteins (OBPs) specifically defined in insect olfactory physiology?
(A) Proteins in the lymph that transport odorants to dendritic receptors.
(B) Large structural proteins that anchor the sensillum to the cuticle.
(C) Enzymatic proteins inside the neuron that strictly degrade signaling.
(D) Massive neurohormones released by the brain to increase sensitivity.

NODIA

2013

141. Factually, the aqueous fluid that bathes the sensory dendrites within a chemosensory sensillum and into which the odorants or tastants must dissolve is termed:
(A) Ecdysial fluid
(B) Intracellular plasma
(C) Sensillum lymph
(D) Synaptic cleft fluid

2003

142. Based on classical structural classifications of chemoreceptors, a basiconic peg that is short, heavily perforated with minute pores across its entire surface, and strictly functions in sensing volatile airborne chemicals is definitively classified as:
(A) Uniporous
(B) Aporous
(C) Mechanoporous
(D) Multiporous

2012

143. Which specific sterol is almost universally required by all insects as an essential dietary nutrient because it acts as the vital, irreplaceable structural precursor for the synthesis of ecdysteroid molting hormones?
(A) Ergosterol
(B) Stigmasterol
(C) Cholesterol

(D) Sitosterol

2010

144. Factually, many insects strictly require certain polyunsaturated fatty acids in their diet, most notably to ensure proper wing expansion and successful emergence during the final adult molt. Which of the following is the most commonly essential fatty acid?
(A) Linoleic acid
(B) Palmitic acid
(C) Stearic acid
(D) Oleic acid

2004

145. Consider the following statements regarding the dietary requirements and biochemical roles of lipids and sterols in insects:
I. Insects cannot synthesize the steroid nucleus (the fundamental sterol ring structure) de novo from simpler molecules like acetate.
II. Phytophagous insects typically convert plant sterols (like sitosterol) into cholesterol via specialized midgut enzymes.
III. Dietary sterols are required solely for hormone synthesis and play zero role in cell membrane structural integrity.
IV. Lipids serve as major energy reserves stored heavily within the fat body.
V. Saturated fatty acids like stearic acid are almost never synthesized internally and must strictly be obtained entirely from the diet.
Which of the above statements are correct?
(A) III and V
(B) I, II, IV
(C) I and V
(D) II, III, IV, V

2019

146. What is the fundamental evolutionary/biochemical cause behind an insect's absolute dietary requirement for a sterol source?
(A) They lack critical enzymes in the squalene-to-sterol biosynthetic pathway.
(B) They require heavy sterols to weigh down the digestive tracts for movement.
(C) They actively excrete all internal sterols continuously through the tubules.
(D) They rely strictly on sterols to act as the primary neurotransmitter in the brain.

2013

147. Conceptually, while many insects can adapt to varying levels of carbohydrates, carbohydrates are primarily processed biochemically to function directly as:
(A) The sole structural component of the exoskeleton, replacing all chitin.
(B) Direct precursors for the synthesis of all complex cuticular wax layers.
(C) The most rapidly mobilized, immediate energy source via trehalose synthesis.
(D) The primary storage form of nitrogen for periods of deep starvation phases.

2002

148. Factually, the primary biochemical site where dietary sugars are absorbed from the hemolymph and actively synthesized into trehalose for sustained release is the:
(A) Fat body
(B) Malpighian tubules
(C) Corpora cardiaca
(D) Prothoracic gland

2022

149. Which of the following statements regarding the amino acid requirements of insects is factually INCORRECT?
(A) Most insects require the same ten essential amino acids famously required by the rat.
(B) Phenylalanine and tyrosine are particularly critical in large amounts just before molting due to their heavy role in cuticular sclerotization.
(C) Insects completely lacking symbiotic microorganisms must obtain all essential amino acids strictly from their diet.
(D) Insects can readily synthesize all necessary aromatic amino acids directly from basic carbohydrates and nitrogen gas.

2019

150. How is the essential amino acid Tryptophan primarily defined in terms of its specialized biochemical role in insect physiology?
(A) Acts exclusively as the monomer unit for massive chitin chain synthesis.
(B) Serves as the precursor for synthesis of ommochrome visual pigments.
(C) Functions as the direct metabolic building block of Juvenile Hormone.
(D) Is heavily cross-linked with quinones to form the solid exoskeleton.

2007

151. Factually, which specific complex of vitamins is almost universally essential in the diet of all actively growing insect larvae because these

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vitamins act strictly as vital coenzymes in fundamental cellular metabolic pathways?
(A) Fat-soluble Vitamin A derivatives.
(B) The various Vitamin K complexes.
(C) The water-soluble B-complex vitamins.
(D) All common Vitamin D variants.

2006

152. Which physiological dependency represents a notable negative exception or highly specific requirement seen primarily in heavily phytophagous (plant-feeding) insects, but generally NOT in strict carnivores or saprophages?
(A) A total inability to process dietary carbohydrates.
(B) A mandatory requirement for dietary Vitamin B12.
(C) Reliance on obtaining cholesterol directly from the diet.
(D) A dietary requirement for Ascorbic acid (Vitamin C).

2004

153. Identify the correct pair that properly links an essential dietary mineral with its specific physiological function in insects.
(A) Potassium – The primary osmotic driver for fluid secretion in the tubules.
(B) Zinc – Forms the core functional center of the hemoglobin in all species.
(C) Calcium – Forms the massive rigid internal skeleton of the thoracic body.
(D) Lead – Required trace element for stabilizing all cuticular cross-links.

2021

154. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): Many phytophagous insects strictly require ascorbic acid (Vitamin C) in their artificial diets for successful growth and development.
Reason (R): Ascorbic acid plays a crucial biochemical role as a powerful antioxidant and is involved in collagen and connective tissue synthesis.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is false but R is true.
(D) A is true but R is false.

2004

155. Conceptually, an artificial insect rearing diet is definitively classified strictly as a "holidic" diet when:
(A) Its composition is formulated entirely from pure chemical compounds.
(B) It contains a mixture of whole plant materials and raw animal tissues.
(C) Its composition consists entirely of complex, agricultural by-products.
(D) It requires continuous supplementation with live, active host insects.

2022

156. Factually, if an entomologist formulates a diet consisting largely of known pure chemicals but decides to add precisely one biologically complex, chemically undefined substance (such as a crude yeast extract) to ensure successful rearing, the diet must be classified as:
(A) Meridic
(B) Oligidic
(C) Holidic
(D) Natural

NODIA

2010

157. Match the artificial diet classification (List I) with its precise technical formulation description (List II):
List I: Diet Classifications
P. Holidic
Q. Meridic
R. Oligidic
S. Axenic
List II: Formulation Descriptions
1. Composed mainly of crude natural plant or animal materials with exact chemical makeup widely unknown.
2. A strictly pure chemical diet where every single molecular constituent is precisely quantified.
3. A diet consisting of pure chemicals supplemented with one or more complex, unrefined biological substances.
4. A rearing environment or diet entirely free from all contaminating microorganisms (sterile).
(A) P-2, Q-3, R-1, S-4
(B) P-3, Q-1, R-4, S-2
(C) P-1, Q-4, R-3, S-2
(D) P-4, Q-1, R-2, S-3

2012

158. What is the primary cause dictating the strict, mandatory inclusion of compounds such as

methyl paraben, sorbic acid, or formaldehyde in almost all practical oligidic and meridic artificial insect diets?

(A) They act as powerful artificial feeding stimulants replacing natural cues.
(B) They chemically stabilize the temperature of the diet during long storage.
(C) They artificially induce premature pupation in crowded laboratory colonies.
(D) They are antimicrobial agents necessary to prevent the growth of fungi.

2019

159. Consider the following statements concerning the general components of an oligidic diet designed for rearing a typical phytophagous caterpillar:

I. It heavily relies on complex undefined bases like agar, wheat germ, and casein.
II. It never requires the addition of a physical gelling or bulking agent.
III. It must typically include a sterol source, often supplied naturally within the crude plant ingredients.

Which of the above statements are correct?

(A) I and II
(B) II and III
(C) I and III
(D) I, II, III

2005

160. Which is the most appropriate primary objective when initially developing and optimizing an artificial diet for mass rearing an economically important insect species?

(A) To ensure the diet is 100% holidic, regardless of costs or time.
(B) To maximize fecundity while minimizing the cost of ingredients.
(C) To replicate the physical texture of the host plant using metals.
(D) To under-nourish larvae to produce massive sterile adult insects.

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ANSWERS

1. (A) Meroblastic superficial cleavage
Most higher insects possess centrolecithal eggs where yolk is concentrated in the center. Cleavage is restricted to the peripheral layer of cytoplasm, hence meroblastic and superficial. The nuclei divide within the yolk and then migrate to the periphery. This process allows the formation of a blastoderm surrounding the central yolk mass.

2. (C) Energid
In the early embryonic development of insects, the zygote nucleus undergoes multiple divisions without cytokinesis. Each resulting nucleus becomes surrounded by a small island of cytoplasm, and this unit is termed an energid. These energids eventually migrate from the yolk mass to the egg periphery to participate in the formation of the cellular blastoderm.

3. (A) The cellular blastoderm is formed solely by the migration of pole cells.
The blastoderm formation involves the migration of numerous energids to the periphery of the egg, not just pole cells. Pole cells are specialized cells that appear early at the posterior end to form the germline. Most of the blastoderm is created when somatic nuclei reach the periplasm, followed by the invagination of membranes.

4. (D) Protocephalon – Develops into the head appendages and brain
The insect germ band differentiates into two primary regions: the protocephalon and the protocorm. The protocephalon is the anterior region that gives rise to the ocular, antennal, and intercalary segments, forming the head and brain. In contrast, the protocorm develops into the thorax and abdomen, carrying the respective appendages and internal organ systems.

5. (C) A is true but R is false.
Insect eggs are centrolecithal, containing a large central yolk mass that restricts cleavage to the peripheral cytoplasm, resulting in meroblastic superficial cleavage. However, the presence of yolk does not prevent the fusion of male and female pronuclei. Fertilization occurs normally before the nuclei begin their mitotic divisions and subsequent migration to the egg periphery.

6. (B) I and III
Blastokinesis involves two distinct movements: anatrepsis and katatrepsis. Anatrepsis is the initial movement where the embryo moves from the egg surface into the yolk mass, often reaching a reversed position. Katatrepsis involves the subsequent movement of the embryo to its final orientation, typically placing the head at the anterior pole of the egg.

7. (D) Completion of body segmentation and appendage formation.
Blastokinesis, the movement of the embryo within the egg, is a highly coordinated process in many insects. In hemimetabolous species, the initiation of these movements is primarily triggered by the completion of major morphological milestones, specifically the formation of body segments and appendages. This physiological readiness ensures the embryo reaches the correct position for hatching.

8. (A) Ectoderm
The ectoderm is the outermost germ layer in the insect embryo and serves as the precursor for several vital systems. It undergoes specific invaginations during development to form the tracheal system, which is used for respiration, and the salivary glands. These structures retain their ectodermal nature, including the production of a cuticular lining.

9. (B) II, III, I, IV
Gastrulation in insects begins with the appearance of a primitive groove along the ventral midline of the germ band. This is followed by the invagination of the median area, leading to the formation of the inner layer consisting of mesoderm and endoderm. Finally, the mesoderm differentiates into specialized splanchnic and somatic layers to form muscles.

NODIA

10. (B) Malpighian tubules
The mesoderm gives rise to the muscular system, fat body, dorsal vessel, and reproductive organs. However, the Malpighian tubules are an exception as they are derived from the ectoderm. Specifically, they develop as outgrowths from the anterior end of the proctodaeum, which is itself

an ectodermal invagination. Consequently, they often possess a cuticular lining.

11. (A) It originates from the endoderm via the proliferation of mesenteron rudiments.
The alimentary canal is formed from three distinct parts. While the foregut and hindgut are ectodermal invaginations, the midgut epithelium originates from the endoderm. It develops from mesenteron rudiments located at the tips of the stomodaeum and proctodaeum. These rudiments proliferate and grow toward each other to eventually enclose the yolk and form the stomach.

12. (C) The differentiation of the somatic layer of the embryonic mesoderm.
During organogenesis, the mesoderm splits into two distinct layers: the splanchnic and somatic mesoderm. The somatic mesoderm is responsible for the development of the skeletal or body wall musculature, which facilitates movement and locomotion. The splanchnic mesoderm, on the other hand, surrounds the gut and gives rise to the visceral muscles that control digestion.

13. (D) An anterior ectodermal invagination that develops into the foregut.
The stomodaeum is the embryonic precursor to the insect foregut. It forms as an anterior invagination of the ectoderm during early development. Because of its ectodermal origin, the foregut is lined with a layer of cuticle known as the intima. This structure eventually differentiates into specialized regions like the pharynx, esophagus, crop, and the proventriculus.

14. (C) The anterior and posterior poles of the invaginated layer.
In the process of insect gastrulation, the inner germ layer is formed through invagination or delamination. The true endoderm typically arises from specific cell populations located at the anterior and posterior poles of this inner layer. These endodermal cells proliferate as mesenteron rudiments, eventually migrating to meet and fuse, thereby forming the functional lining of the midgut.

15. (A) P-3, Q-4, R-2, S-1
Thysanura exhibits ametabolous development, young resembling adults except for size. Odonata shows hemimetabolous development with aquatic nymphs. Lepidoptera undergo holometabolous development, featuring a distinct pupal stage between larvae and adults. Hypermetamorphosis occurs in Neuroptera like Mantispidae, where different larval instars have markedly different forms and behaviors to suit specialized parasitic lifestyles during their post-embryonic development.

16. (D) Hypermetamorphosis
Hypermetamorphosis is a specialized form of holometabolous development where successive larval instars exhibit radical differences in morphology and behavior. Typically, the first instar is a highly active, mobile form like a planidium designed for host seeking. Subsequent instars are usually sedentary, grub-like, and focused entirely on feeding. This strategy is common in parasitic insects like Meloidae.

17. (A) Development of internal wings within imaginal discs.
Holometabolous insects are characterized by endopterygote development, where wings develop internally from specialized clusters of cells called imaginal discs. These structures remain undifferentiated during the larval stages and only expand and harden during the pupal and adult stages. This differs from hemimetabolous insects, where wing pads are visible externally and grow incrementally with each nymphal molt.

18. (C) I, II, III
Dyar's Law and Przibram's Rule describe mathematical patterns in insect growth, relating to sclerotized part dimensions and body weight increases. Ametabolous insects like silverfish continue to molt throughout their lives, even after reaching sexual maturity. However, the pupal stage in holometabolous insects is a non-feeding, transitional period where internal tissues undergo massive reorganization into adult structures.

19. (A) Holometabolous
Holometabolous development involves four distinct life stages: egg, larva, pupa, and adult. The larva is morphologically very different from the adult and often occupies a completely different ecological niche. Therefore, if an insect hatches as a miniature version of the adult and lives in the same habitat, it cannot be holometabolous, as it lacks the specialized larval form.

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20. (D) It reduces intraspecific competition for food between life stages.
The primary evolutionary advantage of holometabolous development is the separation of life stages into distinct niches. Larvae are typically specialized for intensive feeding and growth, while adults are specialized for dispersal and reproduction. By utilizing different food sources and habitats, the different stages of the same species avoid competing with one another, allowing for higher population success.

21. (B) The fully mature, typically winged and reproductively active adult.
In the life cycle of an insect, the imago represents the final stage of post-embryonic development. This stage is characterized by the presence of fully functional wings in pterygote insects and mature reproductive organs. The imago no longer undergoes further molting, except in primitive ametabolous groups, and focuses its biological energy on mating, dispersal, and egg production.

22. (C) Pars intercerebralis of the insect brain.
Prothoracicotropic hormone (PTTH) is a critical neuropeptide that initiates the molting process. It is synthesized by specialized neurosecretory cells located in the pars intercerebralis of the brain. Once produced, PTTH is transported along axons to the corpora cardiaca or corpora allata, from where it is released into the hemolymph to stimulate the prothoracic glands to produce ecdysone.

23. (D) Retention of larval characteristics in the next instar.
Juvenile Hormone (JH) plays a decisive role in determining the outcome of an insect molt. A high concentration of JH in the hemolymph ensures that the insect retains its juvenile or larval characteristics after the next molt. When JH levels drop significantly, the ecdysone-induced molt leads to pupation or adult transformation, as seen in holometabolous insects.

24. (C) Brain releases PTTH → Prothoracic gland releases Ecdysone → Epidermis molts
The hormonal regulation of molting follows a hierarchical sequence. First, neurosecretory cells in the brain release prothoracicotropic hormone (PTTH). This hormone travels to the prothoracic glands, stimulating them to secrete ecdysone. Ecdysone is then converted into its active form, 20-hydroxyecdysone, which acts directly on the epidermal cells to trigger the processes of apolysis and the synthesis of a new cuticle.

25. (A) Both A and R are true and R is the correct explanation of A.
Molting involves several distinct physiological events regulated by specific hormones. Eclosion hormone is responsible for triggering the behaviors and muscle contractions needed for ecdysis, which is the physical shedding of the old cuticle. Following ecdysis, the hormone bursicon is released to manage the subsequent tanning and hardening of the new, soft exoskeleton through the biochemical process known as sclerotization.

26. (B) Maintaining activity of the corpora allata.
20-hydroxyecdysone is the active form of the molting hormone and directly influences the epidermis to undergo apolysis, secrete a new epicuticle, and activate molting fluid. However, it does not maintain the activity of the corpora allata; rather, the activity of these glands, which produce Juvenile Hormone, is regulated by separate brain neurohormones and feedback mechanisms during development.

27. (A) Juvenile Hormone – Corpora allata
Juvenile hormone is synthesized and secreted by the corpora allata, which are paired endocrine glands located behind the brain. Ecdysone is produced by the prothoracic glands in the thorax. PTTH is produced by the brain and stored in the corpora cardiaca. Bursicon is generally released from the perisympathetic organs and the central nervous system after the adult emerges.

28. (B) II, IV, V
Metamorphosis is triggered when ecdysteroids act in the absence of juvenile hormone. PTTH release into the hemolymph can occur via different neurohemal organs depending on the insect order. Chemically, juvenile hormone is an acyclic sesquiterpenoid. While eclosion hormone triggers shedding behavior, bursicon controls tanning. The corpora allata do not always degenerate permanently; they often remain functional in adults.

29. (B) Recovering nutrients like amino acids and structural proteins.
The exuviae, or shed exoskeleton, contains significant amounts of valuable structural proteins and chitin that was not digested by the molting fluid. Many insects consume their

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exuviae immediately after molting to reclaim these essential resources. This behavior provides an immediate nutritional boost and helps recover the metabolic investment used to build the previous cuticle, supporting the new one.

30. (D) Separation of the epidermis from the cuticle.
Apolysis is the initial stage of the molting cycle. It involves the physical detachment of the epidermal cells from the overlying old cuticle. Once this separation occurs, the space created is filled with molting fluid, and the epidermis begins to synthesize a new epicuticle. This process precedes ecdysis, which is the actual shedding of the old, now detached, exoskeleton.

31. (C) Cross-linking of proteins by quinones to stiffen.
Sclerotization is a biochemical process that occurs shortly after ecdysis to harden the new exoskeleton. It involves the chemical cross-linking of cuticular proteins, such as arthropodin, using quinones derived from phenolic precursors like dopamine. This transformation creates a rigid, dark, and water-resistant exocuticle. Without sclerotization, the insect would remain soft and vulnerable to mechanical damage and dehydration.

32. (B) Pharate stage
The pharate stage refers to the period during which an insect has already formed its new cuticle but remains enclosed within the old, unshed cuticle. This condition occurs after apolysis has taken place. The term is often used to describe the adult insect while it is still inside the pupal case, waiting for the appropriate environmental or hormonal cues.

33. (D) The new cuticulin layer is chemically resistant and protects underlying layers.
Molting fluid contains powerful enzymes like chitinases and proteases that digest the old endocuticle. To prevent these enzymes from damaging the newly forming tissues, the epidermis first secretes a thin, chemically resistant layer called the cuticulin layer. This layer acts as a protective barrier, ensuring that only the old cuticle is broken down while the new procuticle develops safely.

34. (A) Ecdysial lines, which lack the rigid xocuticular layer
During ecdysis, the insect must break open its old exoskeleton to emerge. This is facilitated by specialized regions called ecdysial lines or sutures, usually located on the dorsal thorax and head. These lines lack the hard exocuticular layer, making them structurally weak. When the insect increases its internal pressure by swallowing air, the cuticle splits along these specific lines.

35. (C) N-acetyldopamine (NADA) serves as a precursor for quinone cross-linking.
Sclerotization is a complex biochemical pathway. It begins with the amino acid tyrosine, which is converted into DOPA and then into dopamine. Dopamine is subsequently acetylated to form N-acetyldopamine (NADA) or N-beta-alanyldopamine (NBAD). These molecules are oxidized by enzymes into quinones, which then act as the cross-linking agents that bind cuticular proteins together, resulting in a hardened exoskeleton.

36. (A) They lack any distinct body segmentation and appendages.
Eruciform larvae, such as those of butterflies and moths, are characterized by a cylindrical, well-segmented body. They possess a distinct, sclerotized head capsule and specific appendages including three pairs of thoracic legs and several pairs of fleshy abdominal prolegs. These prolegs are equipped with tiny hooks called crochets. Claiming they lack segmentation or appendages is factually incorrect.

37. (D) Campodeiform
Campodeiform larvae are named for their resemblance to the primitive insect genus Campodea. They are typically flattened and highly mobile, featuring a prognathous head with well-developed mouthparts. Their long thoracic legs and terminal abdominal cerci are adaptations for an active, predatory lifestyle. This larval form is commonly found in many families of Coleoptera and Neuroptera, where searching for prey is essential.

38. (B) Eggs deposited directly onto or inside an abundant, localized food source.
Apodous larvae, which lack any form of thoracic or abdominal legs, are frequently found in species where the larvae do not need to travel to find food. This adaptation is common in insects

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that deposit eggs directly into nutrient-rich environments, such as decaying organic matter, plant tissues, or animal hosts. Consequently, the energy required to develop complex legs is conserved.

39. (C) I and III
Scarabaeiform larvae are commonly known as "white grubs" and are characteristic of the beetle family Scarabaeidae. They possess a robust, C-shaped body and a well-developed head capsule with thoracic legs. However, they typically lack abdominal prolegs, which distinguishes them from eruciform larvae. These grubs are usually slow-moving and live in soil or wood, where they feed on roots.

40. (A) Both A and R are true and R is the correct explanation of A.
Campodeiform larvae require advanced sensory and locomotor systems because their survival depends on the active pursuit and capture of prey. Their long legs provide the speed necessary for hunting, while specialized receptors allow them to detect vibrations and chemical cues from mobile victims. In contrast, sedentary apodous larvae inhabit environments where food is abundant, reducing the need for complex structures.

41. (A) Presence of thoracic legs and absence of functional abdominal prolegs.
The term oligopod refers to a larval form that possesses the three standard pairs of jointed thoracic legs but lacks any abdominal prolegs. This classification includes various specialized shapes such as campodeiform and scarabaeiform larvae. These insects rely entirely on their thoracic appendages for locomotion, which distinguishes them from polypod larvae that use both thoracic and abdominal appendages to move.

42. (B) Chrysalidiform
Standard morphological classifications for insect larvae include types such as elateriform, vermiform, eruciform, and campodeiform. The term "chrysalis" specifically refers to the pupal stage of a butterfly, not a larval form. Therefore, "chrysalidiform" is not a recognized technical term for describing larval morphology. Larval types are defined by their body shape, degree of sclerotization, and the presence of appendages.

43. (B) Exarate pupa – Hymenoptera (Bees and various wasps)
Exarate pupae are characterized by appendages that are free from the body wall and clearly visible. This type is extremely common in the orders Hymenoptera and Coleoptera. In contrast, obtect pupae have appendages fused to the body and are typical of Lepidoptera. Coarctate pupae, found in many Diptera, are enclosed within a puparium, which is the hardened larval skin.

44. (C) P-3, Q-1, R-2, S-4
Obtect pupae have their appendages firmly glued to the body, while exarate pupae have free appendages. Coarctate pupae are unique because the pupa is hidden inside a puparium formed from the final larval skin. Decticous pupae possess functional, articulated mandibles that allow the emerging adult to chew through the cocoon or substrate. These classifications are based on appendage attachment.

45. (C) The mobility and function of the pupal mandibles.
The primary morphological distinction between decticous and adecticous pupae is based on the mandibles. Decticous pupae have strongly sclerotized, articulated, and functional mandibles operated by the muscles of the developing adult. These are used to escape from the cocoon. Adecticous pupae, which are much more common, lack these functional mandibles and use other methods to emerge from their pupal cases.

46. (D) Puparium
In many higher Diptera, the final larval skin is not shed during the transition to the pupal stage. Instead, it hardens and darkens to form a protective barrel-shaped casing known as the puparium. The true pupa develops inside this structure and is typically of the exarate type. This adaptation provides an extra layer of protection against environmental hazards and predators.

47. (C) Sclerotized exterior with appendages fused immovably to the body.
Obtect pupae are characterized by a heavily sclerotized outer surface where the developing wings, legs, and antennae are fused and glued to the body. This creates a compact and relatively smooth form. This pupal type is characteristic of the Lepidoptera, such as butterflies and moths.

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The fusion of appendages provides structural stability and reduces the risk of damage during metamorphosis.

48. (B) Butterflies
The term "chrysalis" is specifically used to describe the pupal stage of butterflies. Unlike the pupae of many moths, which are often hidden inside silk cocoons or underground, a chrysalis is typically exposed and attached to a substrate by a silk pad. These structures often exhibit intricate shapes and camouflaged colors to avoid detection by predators while the internal metamorphosis occurs.

49. (D) Protection from predators provided by the retained larval cuticle.
The coarctate pupal form offers a significant survival advantage by utilizing the final larval cuticle as a tough, protective shield. This puparium acts as a physical barrier against predators, parasites, and desiccation. Because the pupa itself is delicate and immobile, having a hardened external casing derived from a previously functional skin is an energetically efficient way to ensure safety during transformation.

50. (A) Excretion of uric acid and intensive reabsorption of water and salts.
The proctodaeum, or hindgut, serves as the final section of the insect alimentary canal. Its primary physiological functions involve the final processing of waste materials received from the midgut and Malpighian tubules. The rectum is particularly specialized for the intensive reabsorption of water, salts, and essential nutrients from the feces and urine, which is crucial for maintaining osmotic balance.

51. (C) Ectoderm
The insect alimentary canal develops from different embryonic layers. The foregut and hindgut are formed from ectodermal invaginations, while the midgut (mesenteron) is derived from the endoderm. In some developmental models, the mesoderm may also contribute to the muscular layers surrounding the gut, but the epithelial lining is endodermal. Ectoderm is responsible for structures that typically possess a cuticular lining.

52. (A) I and III
The stomodaeum is the anterior portion of the gut and is embryologically derived from the ectoderm. It consists of the pharynx, esophagus, crop, and ends with the proventriculus, which acts as a valve or grinding organ. While it is lined with a cuticular intima, this lining is an extension of the exoskeleton. These features facilitate the initial storage and mechanical processing.

53. (D) Intima
The foregut and hindgut are lined with a layer of cuticle called the intima, which is continuous with the external exoskeleton. This lining protects the delicate epithelial cells from mechanical abrasion caused by solid food particles. In some insects, the intima in the proventriculus is modified into teeth or spines for grinding. Because it is cuticular, the intima is shed during molting.

54. (B) The midgut epithelium is specialized for enzyme secretion, which a cuticle hinders.
The foregut is primarily responsible for the ingestion and mechanical processing of food, requiring a protective cuticular intima. In contrast, the midgut is the principal site for the secretion of digestive enzymes and the absorption of nutrients. A thick cuticular lining would act as a barrier to these processes. Instead, the midgut often uses a semi-permeable peritrophic membrane for protection.

55. (C) The midgut does not shed a cuticle as it is an endodermal derivative.
During the molting process, an insect sheds the cuticular linings of the foregut, hindgut, and tracheal system, as these are all ectodermal in origin. However, the midgut is derived from the endoderm and lacks a true cuticular intima. Consequently, the midgut epithelium is not shed along with the outer exoskeleton. Instead, its lining may undergo periodic regeneration through specialized cells.

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56. (D) The active transport required for water conservation against gradients.
In arid environments, insects must conserve water. The rectal epithelium of these insects often contains specialized cells with highly folded apical membranes and a high density of mitochondria. These features support the active transport of ions and water back into the hemolymph against steep osmotic gradients. This metabolic investment allows the insect to produce extremely dry excrement, minimizing critical water loss.

57. (A) Chitin microfibrils in a protein-carbohydrate matrix.
The peritrophic membrane is a semi-permeable envelope that surrounds the food bolus in the midgut of many insects. It is composed of a complex network of chitin microfibrils embedded in a matrix of proteins and glycoproteins. This structure protects the midgut epithelium from mechanical damage and pathogens while allowing the passage of digestive enzymes and the products of digestion.

58. (B) Filter chamber – Direct shunting of excess water to the hindgut.
Sap-feeding insects like aphids ingest large volumes of liquid diet that is rich in sugars but poor in nitrogen. To efficiently concentrate nutrients, they possess a specialized anatomical modification called a filter chamber. This structure allows excess water to bypass the main absorptive section of the midgut and move directly to the hindgut for excretion, preventing excessive dilution.

59. (A) Being delaminated continuously from the entire length of the midgut epithelium.
Insects produce two main types of peritrophic membranes. Type I is formed by the delamination of cells along the entire length or a large portion of the midgut epithelium. This process often occurs in response to feeding. Type II, by contrast, is produced continuously by a specialized ring of cells located at the anterior end of the midgut, near the stomodaeal valve.

60. (A) Both A and R are true and R is the correct explanation of A.
The peritrophic membrane primarily functions to protect the midgut epithelium from the mechanical wear of solid food and to provide a barrier against pathogens. Because Hemipterans typically feed on liquid diets such as plant sap or blood, the risk of physical abrasion is minimal. Consequently, most members of this order have evolved to lack a peritrophic membrane.

61. (C) Anatomical modification to bypass water and concentrate nutrients.
The filter chamber is a complex arrangement found in the digestive tract of many Hemiptera. It involves the close association of the posterior midgut or hindgut with the anterior midgut. This physical proximity facilitates the rapid osmotic transfer of water from the ingested sap directly into the excrement, thereby concentrating essential nutrients like amino acids within the midgut for absorption.

62. (D) Large proteins requiring proteases.
The crop is primarily a storage organ in the insect foregut. While some initial digestion can occur here due to enzymes regurgitated from the midgut, it is mostly limited to simple sugars and some lipids. Large, complex proteins require specialized proteases and an environment found only in the midgut. Therefore, significant protein digestion and absorption do not occur in the crop.

63. (C) Trehalase
Trehalose is the principal sugar circulating in the insect hemolymph, serving as a vital energy reservoir. To utilize this sugar for metabolic processes, especially during high-energy activities like flight, the insect employs the enzyme trehalase. This enzyme catalyzes the hydrolysis of one trehalose molecule into two glucose molecules, which can then be directly entered into the glycolytic pathway.

64. (B) Plasmatocytes
Plasmatocytes are one of the most abundant types of hemocytes in insect hemolymph. They are highly polymorphic and mobile cells primarily responsible for the cellular immune response. Their main functions include the phagocytosis of small foreign bodies like bacteria and fungal spores. Additionally, plasmatocytes play a critical role in the encapsulation of larger invaders and the formation of nodules.

65. (A) I and III
Insect hemolymph serves several vital roles, including the transport of nutrients, hormones, and metabolic wastes throughout the body. It also acts as a hydraulic fluid, providing the pressure needed for wing expansion and ecdysis. However, it generally does not play a major role in respiration, as the tracheal system handles gas exchange, and it lacks hemoglobin in most species.

66. (A) They initiate nodulation or form a capsule around the invader.
When an insect encounters a foreign object too large for individual phagocytosis, such as a parasitoid egg, it initiates a multi-cellular response. Hemocytes, particularly plasmatocytes

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and granulocytes, aggregate in layers around the intruder to form a capsule. This process, often followed by melanization, isolates the invader from the hemolymph and can lead to its death by asphyxiation or cytotoxins.

67. (C) A non-reducing disaccharide of two glucose units.
Trehalose is the primary blood sugar in insects, consisting of two glucose molecules joined by an alpha,alpha-1,1-glucosidic bond. As a non-reducing sugar, it is chemically stable and does not react with proteins as easily as glucose. This stability allows insects to maintain high concentrations of trehalose in their hemolymph, providing a ready source of energy that can be rapidly mobilized.

68. (A) Prohemocytes
Prohemocytes are the small, undifferentiated stem cells found in insect hemolymph and hematopoietic organs. They are characterized by a high nucleo-cytoplasmic ratio and the ability to undergo mitosis. Prohemocytes serve as the progenitors for other specialized hemocyte types, such as plasmatocytes and granulocytes. Their continuous division ensures that the insect can replenish its population of immune cells following infection.

69. (D) The extensive network of the tracheal system.
Unlike vertebrates, most insects do not rely on their circulatory system for the transport of respiratory gases. Instead, they possess a highly branched network of air-filled tubes known as the tracheal system. This system delivers oxygen directly to the tissues and removes carbon dioxide via diffusion and active ventilation. This direct delivery bypasses the need for oxygen-binding pigments in the hemolymph.

70. (B) They store and release prophenoloxidase for the melanization cascade.
Oenocytoids are specialized hemocytes that play a crucial role in the insect's humoral immune system. They contain high concentrations of the enzyme prophenoloxidase in their cytoplasm. When triggered by infection or injury, these cells rupture or release their contents, activating the phenoloxidase cascade. This leads to the production of melanin, which is essential for wound healing and parasite encapsulation.

71. (C) Hemocoel
The insect body cavity is not a true coelom but a secondary cavity called the hemocoel. It is formed during embryonic development by the fusion of the embryonic coelom with other cavities. The hemocoel is filled with hemolymph, which bathes all internal organs directly. This open circulatory system allows for the efficient exchange of nutrients and hormones between the fluid and tissues.

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72. (D) Alary muscles
The alary muscles are pairs of thin, fan-shaped muscle sheets located in the dorsal diaphragm. They are attached to the lateral walls of the heart and the tergites of the body wall. Their rhythmic contractions help expand the heart chambers, facilitating the entry of hemolymph through the ostia. This action, combined with the peristaltic contractions of the heart, drives the circulatory flow.

73. (A) Rhythmic heart contractions and valves that prevent backflow.
River flow is primarily driven by the peristaltic contractions of the dorsal vessel, which push fluid toward the head. The vessel is equipped with internal valves and ostia that open and close in a coordinated manner. These valves ensure that the hemolymph moves in a unidirectional path, typically from the posterior abdomen toward the anterior cephalic region, maintaining consistent flow.

74. (B) Ostia
Ostia are the lateral, slit-like openings found in the heart segments of the insect dorsal vessel. They function as one-way valves that allow hemolymph to enter the heart from the surrounding pericardial sinus during the relaxation phase, or diastole. When the heart contracts during systole, the ostia close to prevent the fluid from leaking back out, ensuring an efficient circulatory pulse.

75. (A) They are composed of dense networks of tracheal tubes rather than muscle.
Accessory pulsatile organs are small, muscular pumps located at the bases of long appendages such as antennae, wings, and legs. They are essential for maintaining hemolymph circulation into these narrow structures where the main heart's pressure is insufficient. They are composed of specialized muscle tissue, not tracheal tubes.

These organs function independently to ensure local tissue health and fluid transport.

76. (A) A network of capillaries bridging arteries and veins.
Insects possess an open circulatory system, meaning their hemolymph is not entirely confined to vessels. While they have a dorsal vessel that acts as a heart and aorta, they lack a complex network of microscopic capillaries to connect the arterial and venous sides. Instead, the fluid empties into the hemocoel and directly bathes the organs before returning to the heart.

77. (C) Increased osmotic pressure in muscle cells draws fluid out for gas diffusion.
At rest, the terminal ends of tracheoles contain fluid, which limits the rate of oxygen diffusion. During strenuous activity, such as flight, the metabolic byproducts in the muscle cells increase the osmotic pressure. This causes the tracheolar fluid to be drawn into the tissues, allowing air to move deeper into the tubes. This physical change significantly enhances the efficiency of gas exchange.

78. (B) Both A and R are true and R is the correct explanation of A.
Tracheae are the primary tubes of the insect respiratory system and are lined with cuticle. To prevent these tubes from collapsing under the varying internal pressures of the body while remaining flexible, they are reinforced with spiral or circular thickenings called taenidia. These structures are vital for maintaining an open airway, ensuring that gas exchange can continue during movement.

79. (B) I, II, V
Holopneustic insects have the maximum complement of functional spiracles, typically ten pairs. Apneustic insects lack open spiracles and respire through their skin or gills, common in aquatic larvae. In large insects, diffusion is insufficient to meet oxygen demands, so they use active ventilation. This is achieved through rhythmic muscular contractions of the abdomen that pump air through the tracheal trunks.

80. (B) Atrium
The atrium is the chamber located immediately inside the spiracular opening of the insect tracheal system. It often contains filtering structures like hairs or bristles to prevent dust and parasites from entering. Many insects also possess a valve mechanism at the atrium that can be closed to reduce water loss. This control over the opening is essential for survival in dry environments.

81. (D) A submerged benthic aquatic environment.
An apneustic respiratory system is one in which all spiracles are non-functional or absent. This adaptation is primarily found in aquatic insects that live entirely submerged, such as the larvae of some mayflies. These insects rely on cutaneous respiration or specialized gills to absorb dissolved oxygen directly from the water. In these environments, open spiracles would be a liability, leading to flooding.

82. (A) Autoventilation – Flight muscles compressing thoracic air sacs.
Autoventilation is a specialized respiratory mechanism where the action of the flight muscles themselves drives the movement of air. As the insect flies, the powerful contractions of these muscles alternately compress and expand the large tracheal air sacs in the thorax. This process creates a forceful flow of air through the system, ensuring that the high oxygen demands of flight are met.

83. (C) It acts as a permanent gill that never needs to be replenished at surface.
A plastron is a specialized structural adaptation consisting of a dense mat of hydrophobic hairs that traps a thin, stable layer of air against the body. Unlike a simple air bubble, the plastron's volume remains constant because its surface area is held by the hairs. This allows it to function as a permanent physical gill, facilitating continuous gas exchange with the water.

84. (A) Bubble carried externally that shrinks as oxygen is consumed.
A compressible physical gill is an air bubble trapped by an aquatic insect, often under its elytra or using specialized hairs. As the insect consumes oxygen from the bubble, the partial pressure of oxygen drops, causing more oxygen to diffuse in from the water. However, because nitrogen also diffuses out, the bubble gradually shrinks over time, requiring surface visits.

85. (D) They tap into host tracheal trunks or maintain a connection to outside.
Endoparasitic larvae living inside the hemocoel of a host face significant respiratory challenges.

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Some species have evolved to physically pierce the host's tracheal tubes with their own spiracles, effectively stealing air from the host's supply. Others maintain a posterior connection to the host's integument, using a siphon to breathe atmospheric air. These strategies allow them to thrive in oxygen-poor environments.

86. (B) Mayflies: Lateral margins; Damselflies: Caudal (terminal).
Tracheal gills are specialized outgrowths of the body wall used for underwater respiration. In mayfly nymphs (Ephemeroptera), these gills are typically arranged in pairs along the lateral margins of the abdominal segments. In contrast, damselfly nymphs (Zygoptera) possess three prominent, leaf-like caudal gills at the terminal end of the abdomen. Both structures are highly tracheated to maximize dissolved oxygen absorption.

87. (C) Consumed oxygen lowers partial pressure, causing diffusion into bubble.
An air bubble carried underwater by an insect acts as a gill because of the dynamics of partial pressure. When the insect uses the oxygen within the bubble, the oxygen concentration inside falls below that of the surrounding water. This creates a concentration gradient that drives dissolved oxygen from the water into the bubble. This process significantly extends the duration of submergence.

88. (D) P-2, Q-3, R-4, S-1
Dragonfly nymphs use rectal tracheal gills for breathing. Aquatic Hemiptera like Aphelocheirus rely on a plastron for permanent underwater gas exchange. Mosquito larvae use a siphon tube to breathe atmospheric air at the surface. Bloodworms (Chironomidae) have blood gills and often contain hemoglobin to survive in low-oxygen environments. These adaptations reflect the diverse strategies insects use to manage aquatic respiration.

89. (A) Germarium contains developing oocytes and pre-follicular tissue.
An ovariole is the functional unit of the insect ovary. At its anterior end is the germarium, a region containing primary germ cells and pre-follicular tissue where oocytes are initially formed. Posterior to this is the vitellarium, where the oocytes grow and accumulate yolk. Each ovariole is anchored by a terminal filament and opens into the lateral oviduct through the pedicel.

90. (B) Stores and maintains the viability of received spermatozoa.
The spermatheca is a specialized storage organ in the female insect reproductive tract. Following mating, sperm are transferred to this gland, where they are maintained in a viable state, often for extended periods. This allows the female to fertilize her eggs gradually as they are laid, independent of the timing of copulation. Specialized secretions from the spermathecal gland provide necessary nutrients.

91. (A) Male accessory glands (MAGs).
Male accessory glands are vital components of the insect reproductive system. They secrete the complex seminal fluids that accompany sperm during transfer. In many species, these glands also produce the structural proteins and lipids used to construct the spermatophore, a protective capsule for sperm. Furthermore, MAG secretions can influence female behavior and physiology, often inhibiting further mating or stimulating egg production.

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92. (C) A is true but R is false.
Vitellogenesis is the process of yolk deposition in the developing oocyte. It involves the active uptake of vitellogenins from the hemolymph. While the follicular epithelium may contribute some proteins, the primary site of vitellogenin synthesis in most insects is the fat body. These proteins are secreted into the hemolymph and then transported into the oocyte via receptor-mediated endocytosis.

93. (C) Oocytes rely on the follicular epithelium, lacking trophocytes.
Panoistic ovarioles represent a primitive condition where specialized nurse cells, or trophocytes, are absent. In this type, the developing oocytes obtain their nutrients primarily from the surrounding follicular epithelium and the hemolymph. This is found in orders like Orthoptera. In contrast, meroistic ovarioles contain trophocytes that actively synthesize and transport RNA and proteins to the oocytes to support their rapid growth.

94. (D) Accessory glands
Female accessory glands, also known as colleterial glands, are responsible for secreting the final

coatings of the egg. These secretions can form the protective ootheca in cockroaches or provide the adhesive glue used to attach eggs to leaves or other substrates. These glands open into the genital chamber, ensuring that the substances are applied as the mature egg passes through.

95. (C) Arrhenotoky results in males, while thelytoky results in females.
These terms describe different forms of parthenogenesis, or reproduction without fertilization. Arrhenotoky is a form of haplodiploidy where unfertilized eggs develop into males, while fertilized eggs become females. This is common in Hymenoptera. Thelytoky, on the other hand, is a process where unfertilized eggs develop exclusively into females. This strategy allows for rapid population growth in favorable environmental conditions.

96. (B) Produce hundreds of identical offspring from one fertilized egg.
Polyembryony is a reproductive strategy where a single fertilized egg splits into multiple embryos during early development. This phenomenon is most notable in certain parasitic wasps. It allows the mother to maximize the utilization of a host by producing a large number of genetically identical offspring from a single oviposition event. This effectively increases the reproductive output while minimizing the effort required.

97. (C) II, I, III, IV
Paedogenesis is a specialized reproductive strategy where larvae are capable of producing offspring. The cycle begins with a mother larva hatching from an egg. Within its hemocoel, embryos develop parthenogenetically. These offspring then consume the internal tissues of the mother larva for nourishment. Finally, the new generation of daughter larvae emerges from the remains of the mother's carcass to continue.

98. (A) Embryo derives nourishment from tissues via a placenta structure.
In ovoviviparity, the egg develops and hatches inside the mother, but the embryo relies entirely on the yolk within the egg for its nutrition. In contrast, pseudoplacental viviparity involves a specialized placental-like structure that allows for the transfer of nutrients from the mother's tissues directly to the developing embryo. This provides additional nourishment beyond the initial yolk reserves, supporting advanced growth.

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99. (C) Adenotrophic viviparity
Adenotrophic viviparity is a highly specialized form of reproduction found in tsetse flies. A single egg hatches inside the female's uterus, where the larva is nourished by secretions from modified accessory glands, often called "milk glands." The larva remains inside until it is fully developed and ready to pupate. Immediately upon birth, the larva enters the soil and forms a puparium.

100. (A) Aphids (Aphididae)
Aphids are well-known for their complex life cycles involving cyclical parthenogenesis. During the spring and summer, they reproduce parthenogenetically and viviparously, allowing for extremely rapid population increases of clonal females. As environmental conditions change in the autumn, they produce a sexual generation that mates and lays overwintering eggs. This strategy combines rapid asexual expansion with the genetic diversity of sexual reproduction.

101. (D) Prothoracic ganglion
The visceral or stomatogastric nervous system is responsible for regulating the internal organs, particularly the gut. Its main components include the frontal ganglion, the hypocerebral ganglion, and the recurrent nerve. These structures are closely associated with the brain and foregut. The prothoracic ganglion, however, is a major component of the central nervous system located in the thorax, controlling movement.

102. (C) I and III
The insect brain is composed of the protocerebrum, deutocerebrum, and tritocerebrum. The subesophageal ganglion, located below the esophagus, is formed by the fusion of three ganglia and innervates the mouthparts, including the mandibles and maxillae. While the ventral nerve cord consists of a chain of ganglia, their number and degree of fusion vary greatly among different insect orders and life stages.

103. (C) Compound eyes
The protocerebrum is the most anterior and largest lobe of the insect brain. Its primary function is to process visual information received from the compound eyes and ocelli. It contains specialized regions such as the optic lobes and mushroom bodies. These structures are

essential for complex behaviors, including visual orientation and memory. It serves as the main integration center for sensory inputs.

104. (D) Regulation of movements and processes of the anterior foregut.
The stomatogastric nervous system is a specialized part of the visceral nervous system. It consists of several interconnected ganglia, such as the frontal and hypocerebral ganglia, and nerves that innervate the anterior portion of the digestive tract. Its primary role is to coordinate the muscular movements involved in swallowing, the rhythmic contractions of the esophagus, and the overall mechanical processing of food.

105. (A) Deutocerebrum – Processes olfactory input from the antennae.
The deutocerebrum is the middle lobe of the insect brain and is primarily dedicated to processing sensory information from the antennae. It contains the antennal lobes, which receive olfactory signals, and the antennal mechanosensory centers. This region is critical for detecting chemical cues such as pheromones and food odors, as well as managing the movement of the antennal segments.

106. (B) A chain of segmentally arranged ganglia located ventrally below the gut.
The insect central nervous system is characterized by a ventral nerve cord that runs along the floor of the thorax and abdomen. This cord consists of a series of segmentally arranged ganglia connected by paired nerve cords called commissures and connectives. These ganglia control the local movements and sensory processing of their respective segments. This is a fundamental feature of arthropods.

107. (C) The rapid influx of large, negatively charged intracellular proteins.
During an action potential, depolarization is driven by the rapid opening of voltage-gated sodium channels, leading to a massive influx of positive sodium ions into the neuron. This transiently reverses the membrane potential. Large, negatively charged proteins remain inside the cell and do not move across the membrane. Repolarization is later achieved by the efflux of potassium ions, restoring the negative potential.

108. (A) Both A and R are true and R is the correct explanation of A.
Acetylcholinesterase is a vital enzyme that breaks down the neurotransmitter acetylcholine in the synaptic cleft, ending the signal. Many insecticides work by inhibiting this enzyme. This causes acetylcholine to accumulate, leading to the continuous and uncontrolled stimulation of the post-synaptic neurons. This overstimulation eventually causes muscular paralysis and death of the insect, making these chemicals powerful neurotoxic agents for pest control.

109. (C) The principal inhibitory neurotransmitter
Gamma-aminobutyric acid (GABA) is a major neurotransmitter in the insect central nervous system. Its primary role is to act as an inhibitory signal, reducing the likelihood that a post-synaptic neuron will fire an action potential. By balancing excitatory signals, GABA helps coordinate complex motor behaviors. Many insecticides target GABA receptors to disrupt the normal inhibitory control of the nervous system.

110. (B) I, II, III
Chemical synapses in insects facilitate unidirectional signal transmission. When an action potential reaches the pre-synaptic terminal, it triggers an influx of calcium ions, which causes neurotransmitter-filled vesicles to fuse with the membrane. The transmitters then diffuse across the synaptic cleft to bind with receptors. Unlike electrical synapses, chemical synapses are not physical connections between the cytoplasm of adjacent neurons but rely on diffusion.

111. (C) Enzymatic hydrolysis of the neurotransmitter within the synapse.
To prevent continuous stimulation of the post-synaptic neuron at a cholinergic synapse, the neurotransmitter acetylcholine must be rapidly removed. This is achieved through enzymatic hydrolysis by the enzyme acetylcholinesterase. The enzyme breaks down acetylcholine into choline and acetate, effectively terminating the signal. This process is extremely efficient and essential for the precise timing and coordination of nervous system activity and muscle contraction.

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112. (B) Insect axons are unmyelinated, lacking lipid-rich sheaths and nodes of Ranvier.
Saltatory conduction is a rapid method of nerve impulse propagation where the signal "jumps" between nodes of Ranvier in myelinated axons. This mechanism is absent in insects because their neurons lack the fatty myelin sheaths found in vertebrates. Instead, insect axons are unmyelinated and relatively small in diameter. They rely on continuous conduction along the axonal membrane, which is slower.

113. (D) An extreme necessity to conserve water in intensely dry, arid environments.
The cryptonephric system is a specialized anatomical arrangement where the distal ends of the Malpighian tubules are closely held against the rectum by a perinephric membrane. This configuration creates an extremely efficient mechanism for water reclamation. By utilizing a high osmotic gradient, the tubules can extract water from the rectal contents and return it to the body, supporting survival in arid environments.

114. (D) I, II, III, IV
The excretory process begins with the active transport of ions into the Malpighian tubules, which creates an osmotic gradient. This causes water and soluble wastes to enter the tubule lumen. This primary urine then flows into the hindgut. In the rectum, essential water and ions are selectively reabsorbed back into the hemolymph. Finally, the remaining concentrated wastes are excreted as semi-solid paste.

115. (C) Originate from the ectoderm (proctodaeum) rather than the endoderm.
While the midgut and Malpighian tubules are both involved in processing internal fluids, they have different embryonic origins. The midgut is derived from the endoderm. In contrast, Malpighian tubules are ectodermal outgrowths that develop from the junction of the midgut and the hindgut (proctodaeum). Because of their ectodermal nature, they often possess a thin cuticular lining, reflecting their structural relationship to the hindgut.

116. (A) Isosmotic fluid with water, ions, and organic molecules.
The primary urine produced in the distal regions of the Malpighian tubules is an isosmotic filtrate. It is formed through the active transport of potassium and sodium ions, which pulls water, small organic molecules, and nitrogenous wastes into the tubule lumen. This fluid is not yet concentrated; the modification of its volume and composition occurs later in the proximal part of the tubules and rectum.

117. (A) P-4, Q-3, R-2, S-1
Cryptonephric systems involve tubules bound to the rectum for water conservation. Diuresis is the rapid secretion of fluid, often occurring after blood meals. Uric acid is the preferred waste for terrestrial insects due to its low toxicity and insolubility. Ammonotelism is common in aquatic insects where ammonia, though toxic, can be safely diluted and excreted into the surrounding water without cost.

118. (B) Active transport of cations (K^+ or Na^+) creating a strong osmotic gradient.
Unlike the pressure-driven ultrafiltration in vertebrate kidneys, fluid formation in insect Malpighian tubules is an active secretory process. Epithelial cells use ATP-driven pumps to move cations, primarily potassium or sodium, into the tubule lumen. This creates an electrochemical and osmotic gradient that draws water into the tubule. This mechanism allows insects to produce urine efficiently without needing high blood pressure.

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119. (C) Uric acid is insoluble and non-toxic, allowing excretion as dry paste for water.
Uricotelic insects excrete nitrogenous waste as uric acid, which is highly insoluble and relatively non-toxic. This property allows it to be precipitated and excreted as a semi-solid paste with very little water loss. This is a supreme physiological advantage for terrestrial insects, especially those in arid environments, as it allows them to eliminate metabolic nitrogen while maintaining critical internal water balance.

120. (D) The direct excretion of nitrogenous waste primarily as soluble ammonia.
Ammonotelism is an excretory strategy where the primary nitrogenous waste product is ammonia. Because ammonia is highly toxic, it must be excreted rapidly and requires a large volume of water for dilution. Therefore, this strategy is typically limited to aquatic insects. These insects take advantage of the solubility of ammonia to flush it away directly into the surrounding water through their tubules.

121. (A) Allantoin and allantoic acid
While many insects excrete uric acid directly, some possess the enzymes necessary to break it down further. The enzyme urate oxidase converts uric acid into allantoin, which may then be converted into allantoic acid by allantoinase. These compounds are more soluble than uric acid. This metabolic pathway is part of a broader purine degradation system that varies between different insect orders.

122. (D) Diuretic hormones halt ion transport to instantly conserve water.
Osmoregulation in insects is controlled by both diuretic and antidiuretic hormones. Diuretic hormones stimulate the Malpighian tubules to increase the rate of primary urine secretion, typically by activating ion pumps. Conversely, antidiuretic hormones act on the rectum to increase the reabsorption of water back into the hemolymph. The statement that diuretic hormones halt ion transport is incorrect, as they promote fluid production.

123. (A) Creating massive osmotic gradients to extract water from feces.
Rectal pads or papillae are thickened, highly specialized areas of the rectal epithelium. These structures are packed with mitochondria and feature complex membrane foldings. They function to actively transport ions out of the rectal lumen, creating a high osmotic pressure. This gradient pulls water out of the feces and urine, allowing the insect to reclaim almost all of its water before excretion.

124. (A) Ammonia is toxic and requires immense volumes of water for excretion.
Ammonia is the most toxic form of nitrogenous waste produced during protein metabolism. Its high toxicity means it cannot be safely stored in the body and must be diluted with vast amounts of water to be excreted. This makes it suitable only for aquatic insects. In contrast, uric acid and urea are less toxic and can be handled with much less water.

125. (C) It is likely nocturnal, sacrificing sharp resolution to gather light.
Superposition eyes are a specialized type of compound eye found in many nocturnal insects, such as moths. In these eyes, light from multiple ommatidia is focused onto a single rhabdom, which greatly increases light-gathering sensitivity in dim environments. However, this crossover of light rays results in a sacrifice of image resolution. This adaptation is essential for navigating and detecting movement under low light.

126. (D) The corneal lens and crystalline cone
A single ommatidium consists of two main functional parts: the dioptric apparatus and the receptor apparatus. The dioptric apparatus is responsible for gathering and focusing incoming light. It is composed of the outermost corneal lens, which is a modified part of the cuticle, and the underlying crystalline cone. Together, these structures act as a focusing lens system that directs light onto the sensory rhabdom.

127. (C) Retinula cells
Retinula cells are the primary sensory neurons of the insect eye. Each ommatidium typically contains six to eight of these specialized cells. They contain photopigments, such as rhodopsin, located within their microvillar edges. When light strikes these pigments, it triggers a biochemical cascade that results in an electrical signal. This process of phototransduction is how light energy is converted into a neural signal.

128. (B) Rhabdom
The rhabdom is the central, light-sensitive rod located in the core of an ommatidium. It is formed by the fused or closely apposed microvillar projections, called rhabdomeres, from the surrounding retinula cells. The rhabdom acts as a light guide, trapping and absorbing photons through its visual pigments. This structure is the site where light is detected and the neural signaling is initiated.

129. (D) Dorsal ocelli – Sensitivity to light changes for flight stability.
Dorsal ocelli are simple eyes found on the heads of many adult insects. While they are incapable of forming clear images due to their lack of a focusing mechanism, they are extremely sensitive to changes in light intensity. This allows them to detect rapid movements. In flying insects, the ocelli provide critical feedback for maintaining flight stability and orientation by responding to ambient light.

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130. (A) Pigment granules migrate upward to allow light rays to cross over.
In superposition eyes, the distribution of screening pigments determines how much light reaches the rhabdoms. During adaptation to the dark, pigment granules migrate upward toward the corneal surface. This clears a "clear zone" between the crystalline cones and the retinula cells, allowing light from several adjacent ommatidia to converge on a single rhabdom. This maximizes light sensitivity for functioning in low-light conditions.

131. (D) P-3, Q-4, R-1, S-2
Trichoid sensilla are tactile hairs in sockets. Campaniform sensilla detect cuticular stress. Chordotonal organs are internal stretch receptors located between points of the body wall. The tympanum is a specialized membrane system used for hearing. These various mechanoreceptors allow the insect to monitor its body position, detect external physical contact, and perceive environmental sound waves and vibrations, which are essential for communication.

132. (A) It consists of a thin membrane linked internally to chordotonal sensilla.
A tympanal organ functions as an ear by using a specialized, thin area of the cuticle called a tympanum. This membrane is stretched over an air sac and is internally connected to a cluster of chordotonal sensilla. When sound waves strike the tympanum, it vibrates, and these mechanical movements are transmitted to the sensilla, which generate neural impulses for detection by the brain.

133. (D) A specialized chordotonal organ located within the antennal pedicel.
Johnston's organ is a complex of scolopidia found in the second antennal segment, or pedicel, of almost all insects. It is a highly sensitive mechanoreceptor that detects movements of the antennal flagellum relative to the head. This organ is used for various functions, such as sensing flight speed and detecting vibrations. It provides the insect with critical information about wind currents.

134. (B) The opening of stretch-activated ion channels in the sensory neuron.
When a trichoid sensillum is physically moved, the mechanical force is transmitted through the hair to its base in the socket. This deformation directly affects the membrane of the attached sensory neuron dendrite. It causes stretch-activated ion channels to open, leading to an influx of ions and a change in membrane potential. If strong enough, it triggers an action potential signaling tactile contact.

135. (C) Scolopidium
The scolopidium is the basic functional unit of all chordotonal organs. It typically consists of three specialized cells: a bipolar sensory neuron, a scolopale cell that forms a protective sheath, and an attachment cell that anchors the unit to the cuticle. These units are designed to detect mechanical stretching or vibrations. By grouping multiple scolopidia, insects create complex sensory structures like Johnston's organ.

136. (D) They are exclusively external, long, filamentous hairs completely exposed to the open environment.
Proprioceptors are internal or surface-level sensors that provide the insect with information about its own body posture and the position of its limbs. They include internal stretch receptors and hair plates located at joints. Unlike long, external tactile hairs used for sensing the environment, proprioceptors are specialized for monitoring internal state and mechanical stress, coordinating movement and maintaining balance during various activities.

137. (A) Is perforated by numerous microscopic pores to allow molecules to enter.
Typical olfactory sensilla differ from tactile receptors in their cuticular structure. To detect volatile chemical molecules, the wall of an olfactory sensillum is perforated with thousands of tiny pores. These pores allow airborne odorants to enter the sensillum lymph and interact with the sensory dendrites. Tactile mechanoreceptors, however, usually have solid cuticular walls and rely on physical deflection of the entire structure.

138. (B) A is true but R is false.
Gustatory or contact chemoreceptors are typically uniporous, meaning they have a single large pore at the tip of the hair for molecule entry. However, these sensilla often contain both chemosensory and mechanosensory neurons. The mechanosensory neuron detects the physical contact of the hair with a surface, while the chemosensory neurons detect specific chemicals. Therefore, the reason provided is false.

NODIA

139. (B) Contact chemoreception (Taste) – Tarsi of the forelegs and mouthparts
Insects primarily perceive taste through contact chemoreceptors located on the mouthparts, such as the palps, and often on the tarsi of their legs. Tarsal taste receptors allow an insect to "taste" a substrate as soon as it lands, which is crucial for identifying food sources. Long-range olfaction, by contrast, is primarily localized to the antennae, where specialized multiporous sensilla detect odors.

140. (A) Proteins in the lymph that transport odorants to dendritic receptors.
Odorant Binding Proteins (OBPs) are small, soluble proteins found in high concentrations within the sensillum lymph of olfactory receptors. Because many odorant molecules are hydrophobic, they cannot easily dissolve in the aqueous lymph. OBPs bind to these molecules at the pores and transport them across the lymph to the receptors on the sensory dendrites. This transport is essential for detecting chemical signals.

141. (C) Sensillum lymph
Sensillum lymph is the specialized aqueous fluid that fills the lumen of a chemosensory sensillum. It bathes the outer dendritic segments of the sensory neurons. This fluid provides the necessary ionic environment for signal transduction and acts as a medium through which odorants or tastants must diffuse to reach their respective receptors. It also contains essential proteins that facilitate the transport of molecules.

142. (D) Multiporous
Chemoreceptors are classified based on the number of pores in their cuticular walls. A sensillum that is covered with many microscopic pores across its entire surface is called multiporous. This structural arrangement is characteristic of olfactory receptors, as it maximizes the surface area for the entry of volatile chemicals from the air. In contrast, uniporous sensilla are typically used for contact chemoreception.

143. (C) Cholesterol
Cholesterol is an essential nutrient for almost all insects because they lack the biochemical pathways required for de novo sterol synthesis. It serves as the primary structural precursor for the production of ecdysteroids, the hormones that regulate molting and metamorphosis. While phytophagous insects can often convert plant sterols into cholesterol, a dietary source is mandatory for their growth and cell membrane integrity.

144. (A) Linoleic acid
Polyunsaturated fatty acids, particularly linoleic acid, are frequently required in the insect diet. These fatty acids are critical for several physiological processes, including the proper formation of the new cuticle and the successful expansion of wings after the final adult molt. A deficiency in these essential lipids often results in developmental failures, such as incomplete ecdysis, highlighting their vital role in development.

145. (B) I, II, IV
Insects are unable to synthesize the steroid nucleus and must obtain sterols from their diet. Phytophagous species often possess enzymes to dealkylate plant sterols like sitosterol into cholesterol. Additionally, lipids are synthesized and stored in the fat body as triacylglycerols, serving as the primary energy reserve. Sterols also play a crucial role in maintaining the fluidity and function of cellular membranes.

146. (A) They lack critical enzymes in the squalene-to-sterol biosynthetic pathway.
The absolute dietary requirement for sterols in insects is due to their inability to perform the complex biochemical steps required to synthesize the steroid ring structure. Specifically, they lack the necessary enzymes to convert squalene into lanosterol, which is the fundamental precursor for all sterols. This evolutionary loss means they must rely entirely on external sources to obtain needed molecules.

147. (C) The most rapidly mobilized, immediate energy source via trehalose synthesis.
While many insects can synthesize lipids from carbohydrates, the primary role of dietary sugars is to provide an immediate and easily accessible energy source. Once absorbed, sugars are converted by the fat body into trehalose, which is released into the hemolymph. Trehalose can be rapidly hydrolyzed into glucose, fueling metabolic processes and high-demand activities such as locomotion, flight, and transitions.

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148. (A) Fat body
The fat body is the central metabolic hub of the insect, analogous to the vertebrate liver. It is the primary site where absorbed dietary carbohydrates, such as glucose, are processed and synthesized into trehalose. This disaccharide is then released into the hemolymph to maintain a constant supply of energy for the body's tissues. This process is critical for metabolic homeostasis.

149. (D) Insects can readily synthesize all necessary aromatic amino acids directly from basic carbohydrates and nitrogen gas.
Insects generally require ten essential amino acids, as they cannot synthesize them de novo. While they can produce some non-essential amino acids, they cannot synthesize aromatic amino acids like phenylalanine or tryptophan from carbohydrates and nitrogen. These must be obtained through the diet or from symbionts. Phenylalanine is particularly important because it is converted to tyrosine, essential for hardening the exoskeleton.

150. (B) Serves as the precursor for synthesis of ommochrome visual pigments.
Tryptophan is an essential amino acid that plays a specialized role in insect physiology beyond its function as a building block for proteins. It is the fundamental precursor for the kynurenine pathway, which leads to the synthesis of ommochromes. These molecules are the primary screening pigments found in the compound eyes of most insects. Without tryptophan, the insect cannot produce these pigments.

151. (C) The water-soluble B-complex vitamins.
Water-soluble B-complex vitamins, such as thiamine and physical variables like temperature, are universally required by insects. These compounds act as vital coenzymes in fundamental metabolic pathways, including the citric acid cycle and the metabolism of proteins. Because insects cannot synthesize these vitamins internally, they must obtain them from their diet or through the activities of endosymbiotic bacteria. A deficiency typically leads to stunted growth.

152. (D) A dietary requirement for Ascorbic acid (Vitamin C).
While many insects can synthesize ascorbic acid internally, many phytophagous species have lost this ability and must obtain it from their host plants. In these insects, ascorbic acid is essential for normal growth, molting, and fertility. Carnivorous and saprophagous insects usually do not show the same strict dietary dependency on Vitamin C, as they can typically meet their requirements through synthesis.

NODIA

153. (A) Potassium – The primary osmotic driver for fluid secretion in the tubules.
Potassium is a critical mineral in insect physiology. It is actively transported into the lumen of the Malpighian tubules by specialized ion pumps. This movement of potassium creates a strong osmotic gradient that draws water and metabolic wastes into the tubules, forming the primary urine. This process is essential for excretion and osmoregulation, allowing insects to produce urine without high pressure.

154. (B) Both A and R are true but R is not the correct explanation of A.
Many plant-feeding insects require Vitamin C for successful development, and it is a standard component of their artificial diets. While it is true that ascorbic acid functions as an antioxidant and is involved in tissue synthesis, its specific and most critical roles in insect development, such as its influence on the molting process, are complex. Thus, the reason does not fully explain the requirement.

155. (A) Its composition is formulated entirely from pure chemical compounds.
A holidic diet is the most precisely defined type of artificial insect rearing medium. It is formulated entirely from pure, chemically defined compounds such as purified amino acids, sugars, and minerals. Because every molecular constituent and its exact concentration are known, holidic diets are invaluable tools for research into specific requirements. However, they are often difficult and expensive to formulate compared to complex diets.

156. (A) Meridic
A meridic diet is defined as one that is composed largely of pure chemical compounds but also includes one or more chemically undefined substances. Common examples of such substances include yeast extract, casein, or wheat germ. These additions are often necessary to provide unidentified growth factors that the insect

requires. This type of diet is more practical for laboratory rearing than strictly holidic diets.

157. (A) P-2, Q-3, R-1, S-4
Holidic diets use only pure chemicals. Meridic diets supplement pure chemicals with complex biological substances like yeast. Oligidic diets are based on crude natural materials like wheat germ. Axenic conditions refer to a sterile environment where only the target insect is present, free from other microorganisms. These classifications reflect the degree of chemical precision and biological complexity involved in formulated insect diets.

158. (D) They are antimicrobial agents necessary to prevent the growth of fungi.
Artificial diets are rich in nutrients and moisture, making them ideal substrates for the rapid growth of contaminating microorganisms such as bacteria and molds. To ensure that the diet remains safe and nutritious for the insect, antimicrobial agents like methyl paraben and sorbic acid are added. These chemicals inhibit the growth of pathogens, allowing for successful mass rearing under laboratory conditions.

159. (C) I and III
Oligidic diets are commonly used for mass rearing because they are cost-effective. They utilize complex, unrefined ingredients like agar and wheat germ to provide essential nutrients. While they must contain a sterol source, it is often supplied naturally within these crude plant materials. Additionally, these diets almost always require a gelling or bulking agent to provide the necessary physical consistency for feeding.

160. (B) To maximize fecundity while minimizing the cost of ingredients.
The primary goal of developing a practical artificial diet for an insect species is to create a medium that supports optimal growth, survival, and reproductive success. For economic efficiency, especially in large-scale programs, the diet should be made as inexpensive as possible by using readily available agricultural by-products. Balancing nutritional quality with the need to minimize costs is the central challenge in optimization.

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CHAPTER 04
Ecology

2009

1. Which of the following best defines the scope of autecology within the context of insect ecology?
(A) The study of an individual insect species and its relationship with the surrounding environment.
(B) The study of the interactions between multiple insect species within a shared agroecosystem.
(C) The comparative analysis of energy flow through different trophic levels in an ecosystem.
(D) The statistical assessment of insect biodiversity across distinct biogeographical realms.

2015

2. According to ecological principles, which term specifically describes the physical location or environmental space in which an insect species lives?
(A) Ecological niche
(B) Trophic level
(C) Habitat
(D) Biome

2012

3. Which of the following statements INCORRECTLY characterizes the historical development of insect ecology?
(A) The integration of mathematical population dynamics emerged primarily in the late 20th century.
(B) Early ecological studies focused heavily on purely observational natural history.
(C) Synecology emerged as a distinct branch focused on community-level interactions.
(D) The concept of the ecological niche was foundational to understanding species distribution.

2001

4. In evaluating the effects of abiotic factors, which metric is most appropriately used to quantify the total heat required by an insect to complete its development?
(A) Optimum temperature threshold
(B) Critical photoperiod
(C) Supercooling point
(D) Thermal constant (degree-days)

2012

5. The basic formula for calculating accumulated degree-days (DD) for insect development, where $T_{\max}$ is maximum temperature, $T_{\min}$ is minimum temperature, and $T_{\{base\}}$ is the developmental threshold, is correctly represented by which of the following?
(A) $DD = (T_{\max} - T_{\min}) + T_{\{base\}}$
(B) $DD = \frac{T_{\max} + T_{\min}}{2} - T_{base}$
(C) $DD = \frac{T_{\max} \times T_{\min}}{T_{base}}$
(D) $DD = \frac{T_{\max} - T_{base}}{2}$

2006

6. A sudden drop in environmental temperature below an insect's lower developmental threshold will primarily result in which of the following physiological responses?
(A) Accelerated molting to reach the adult stage rapidly.
(B) Immediate induction of obligate diapause regardless of photoperiod.
(C) A temporary cessation of growth and development known as quiescence.
(D) An increase in basal metabolic rate to generate internal heat.

2025

7. Which of the following describes the most relevant distinction between obligate and facultative diapause in insects?
(A) Obligate diapause is triggered by unexpected environmental stress, whereas facultative diapause occurs in every generation.
(B) Obligate diapause only affects the pupal stage, whereas facultative diapause only affects the egg stage.
(C) Obligate diapause is characteristic of multivoltine insects, whereas facultative diapause is characteristic of univoltine

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insects.

(D) Obligate diapause is genetically programmed to occur in every generation, whereas facultative diapause is environmentally induced.

2001

8. Which of the following represents an EXCEPTION to the general rule that increased temperature linearly increases insect developmental rate?

(A) Excessive heat leading to enzyme denaturation and reduced growth.

(B) Temperatures dropping slightly below the optimum range for maximum growth.

(C) Fluctuating diurnal temperatures that remain entirely within the favorable developmental range.

(D) Gradual acclimatization to marginally warmer seasonal temperatures.

2012

9. In insect ecology, how does varying light intensity typically influence behavior differently than photoperiod?

(A) Light intensity regulates seasonal diapause, whereas photoperiod dictates immediate flight and foraging behavior.

(B) Intensity regulates daily activity rhythms, while photoperiod cues seasonal developmental changes.

(C) Light intensity determines the structural development of the compound eyes, whereas photoperiod determines the ocelli.

(D) Light intensity has no measurable effect on behavior, whereas photoperiod controls all basic physiological rhythms.

2004

10. Consider the following statements regarding abiotic factors and insect development:

I. Photoperiod is the primary environmental cue for inducing facultative diapause in many temperate insects.

II. High relative humidity always increases the survivorship of insect eggs regardless of species.

III. Edaphic factors such as soil texture strongly influence the pupation success of soil-dwelling larvae.

Identify the correct combination of statements.

(A) I and III

(B) I and II

(C) I, II, and III

(D) II

NODIA

2007

11. Which classification correctly categorizes an insect that relies on wind currents to travel hundreds of kilometers, controlling only its takeoff and landing?

(A) Passive wind-assisted migration.

(B) Active tethered flight behavior.

(C) Phoresy through host attachment.

(D) Random walk dispersal pattern.

2001

12. Which of the following pairs concerning spatial distribution patterns and their variance-to-mean ($\frac{V}{M}$) ratios is correct?

(A) Random distribution : $\frac{V}{M} > 1$

(B) Clumped distribution : $\frac{V}{M} = 1$

(C) Uniform distribution : $\frac{V}{M} < 1$

(D) Aggregated distribution : $\frac{V}{M} = 0$

2017

13. The Negative Binomial distribution is most commonly applied in insect ecology to model which specific phenomenon?

(A) The exactly uniform spacing of territorial predators.

(B) The random distribution of a highly polyphagous insect in a homogenous environment.

(C) The progressive expansion of an invasive species' range over time.

(D) The aggregated or clumped distribution of insect pests within an agricultural field.

2017

14. An ecologist observes that a particular insect species exhibits a variance-to-mean ratio significantly greater than 1. What is the most appropriate ecological inference to draw from this data?

(A) The population is experiencing severe intraspecific competition that leads to strict territoriality.

(B) The individuals are independently and randomly utilizing the available habitat.

(C) An aggregated or clumped distribution, likely due to localized resource abundance.

(D) The population is in the exponential phase of growth with zero mortality.

2006

15. The following question consists of two statements, one labeled as Assertion (A) and the other as Reason (R).

Assertion (A): Tethered flight experiments often overestimate the actual migratory flight duration of insects under natural conditions.

Reason (R): In tethered flight, insects do not experience natural visual feedback, wind shear, or the ability to land at will, which normally regulate flight termination.

Select the correct answer from the options below:

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2002

16. What is the primary evolutionary advantage of phoresy as a dispersal mechanism for certain small arthropods?

(A) It allows them to interbreed with closely related species during transit.
(B) It provides a mechanism to avoid parasitoid attack while remaining stationary within the topsoil.
(C) It triggers the transition from the larval to the pupal stage.
(D) It results in reduced metabolic energy costs required to colonize new and distant habitats.

2011

17. Wallace's Line represents a major biogeographical boundary separating which two major ecozones?

(A) Oriental (Indomalayan) and Australasian realms
(B) Nearctic and Neotropical realms
(C) Palearctic and Afrotropical realms
(D) Neotropical and Australasian realms

2015

18. Which statement INCORRECTLY characterizes the principles of zoogeography applied to insects?

(A) Endemism refers to species being unique to a defined geographic location.
(B) Continental drift theory helps explain the disjunct distributions of certain ancient insect lineages.
(C) The Nearctic realm exhibits the highest overall insect biodiversity compared to the Neotropical realm.
(D) Biogeographical realms are separated by natural barriers such as oceans, mountain ranges, or deserts.

2006

19. In biodiversity assessment, how does beta diversity conceptually differ from alpha diversity?

(A) Beta diversity measures species turnover between habitats; alpha measures diversity within a single habitat.
(B) Beta diversity measures total species richness within a single, uniform habitat, while alpha diversity measures genetic variation.
(C) Beta diversity represents the total landscape diversity, while alpha diversity represents global diversity.
(D) Beta diversity only accounts for pest species, while alpha diversity accounts for natural enemies.

2006

20. Consider the following statements regarding biodiversity indices:

I. The Shannon-Wiener index accounts for both species richness and evenness.
II. A higher Simpson's dominance index value indicates a highly diverse and evenly distributed community.
III. Gamma diversity represents the overall diversity across a large region or landscape.
IV. Alpha diversity is strictly a measure of population density, not species composition.

Identify the INCORRECT combination of statements.

(A) II and IV
(B) I, II, and III
(C) I and III
(D) III and IV

2025

21. Which mathematical parameter defines the intrinsic rate of natural increase under ideal, uncrowded environmental conditions?

(A) K
(B) $r_{\{}\max_{\}}$
(C) R_0
(D) T

2003

22. In the logistic population growth model, represented by the equation $\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$, what happens to the population growth rate as N approaches K?

(A) The growth rate increases exponentially.
(B) The population immediately crashes to extinction.

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(C) The growth rate becomes zero.
(D) The intrinsic rate of increase (r) becomes negative.

2012

23. A localized population of aphids experiences a rapid explosion in numbers followed by a sudden collapse due to resource depletion. This pattern is most indicative of which ecological concept?
(A) Strict K-selected life history traits.
(B) Competitive exclusion of the population by a dominant and more efficient secondary herbivore.
(C) Successful implementation of long-term mechanical control.
(D) r-selected growth temporarily exceeding the environmental carrying capacity.

2022

24. Which of the following is an EXCEPTION to the characteristics typically associated with r-selected insect species?
(A) Extensive parental care
(B) High fecundity
(C) Small body size
(D) Short generation time

2019

25. Match the ecological concepts in List I with their corresponding definitions in List II.
List I: (Ecological Concepts)
P. Natality
Q. Carrying capacity (K)
R. Biotic potential
S. Environmental resistance
List II: (Definitions)
1. The maximum population size an environment can sustainably support.
2. The inherent capacity of a population to increase under optimal conditions.
3. The combined abiotic and biotic factors that limit population growth.
4. The birth rate or production of new individuals in a population.
(A) P-4, Q-1, R-2, S-3
(B) P-2, Q-3, R-4, S-1
(C) P-4, Q-2, R-1, S-3
(D) P-1, Q-4, R-2, S-3

2012

26. The concept of biotic potential was formally introduced to the field of ecology by which prominent scientist?
(A) Charles Elton
(B) R.N. Chapman
(C) G.F. Gause
(D) C.S. Holling

2007

27. According to ecological theory, environmental resistance acts primarily to counterbalance which of the following forces?
(A) Biotic potential
(B) Interspecific competition
(C) Trophic energy transfer
(D) Ecological succession

2007

28. Which of the following represents the most appropriate description of a natural ecosystem's stability compared to a typical modern agroecosystem?
(A) Natural ecosystems are less stable due to the absence of human-applied chemical inputs.
(B) Agroecosystems are inherently more stable because of uniform genetic crop planting.
(C) Natural ecosystems have higher stability driven by greater species diversity and complex food webs.
(D) Both systems share identical resilience to invasive pest outbreaks.

2004

29. A major ecological distinction between primary and secondary succession in insect communities is that secondary succession:
(A) Occurs on completely barren substrates devoid of previous biological life.
(B) Is characterized entirely by the arrival of specialized climax community species at the start.
(C) Excludes the participation of any herbivorous insects.
(D) Results in rapid progression due to the presence of a soil matrix and biological legacy.

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2006

30. Consider the following statements regarding the Agro-Ecosystem Analysis (AESA) methodology:
I. It relies heavily on measuring the ratio of pests to natural enemies.
II. It incorporates the assessment of plant health and compensation capacity.
III. It dictates calendar-based chemical spray schedules independent of field data.
IV. It utilizes weather parameters to inform pest management decisions.
V. It aims to empower farmers through observational decision-making.

Identify the correct combination of statements.
(A) I, II, IV, and V
(B) I, III, IV, and V
(C) II, III, and V
(D) I, II, and III

2007

31. The 10% law of energy transfer in ecological food chains implies that:
(A) Predators are limited to consuming 10% of the prey population before being forced to migrate.
(B) Primary producers capture 10% of the sun's total emitted energy.
(C) Only 10% of energy is transferred from one trophic level to the biomass of the next level.
(D) Insects allocate exactly 10% of their energy to reproduction.

2021

32. Which type of ecological pyramid is most likely to be inverted in a forest ecosystem where a single large tree supports thousands of herbivorous insects?
(A) Pyramid of Energy
(B) Pyramid of Numbers
(C) Pyramid of Biomass
(D) Pyramid of Productivity

2018

33. Which term refers to the evolutionary process wherein two competing species utilize different segments of a shared resource to reduce direct competition?
(A) Competitive exclusion
(B) Character displacement
(C) Biomagnification
(D) Resource partitioning

2017

34. Gause's Law of competitive exclusion explicitly dictates that:
(A) Predators will always drive their primary prey species to local extinction.
(B) Parasitoids are inherently better competitors than generalist predators.
(C) Two species with identical niches cannot coexist indefinitely in the same habitat.
(D) Intraspecific competition is consistently weaker than interspecific competition in all cases.

2015

35. In the Lotka-Volterra predator-prey mathematical model, the term aNP represents which critical interaction?
(A) The natural mortality rate of the predator in the absence of prey.
(B) The intrinsic growth rate of the prey population.
(C) The rate at which prey are killed by the predator population.
(D) The carrying capacity of the habitat for the prey.

2018

36. C.S. Holling described three types of functional responses. A Type II functional response curve is best characterized by which of the following?
(A) A linear increase in prey consumption as prey density increases, with no upper limit.
(B) A sigmoidal (S-shaped) curve where consumption is initially low due to lack of search image, then increases before plateauing.
(C) A decelerating rate of prey consumption that eventually plateaus due to predator handling time.
(D) A continuous decrease in consumption as prey density increases.

2022

37. Which of the following correctly pairs a functional response type with its defining mechanism?
(A) Type I : Handling time dictates the plateau shape.
(B) Type II : Learning or search image formation at low prey densities.
(C) Type I : Sigmoidal curve influenced by predator interference.
(D) Type III : Sigmoidal curve influenced by learning or switching behavior.

2003

38. The numerical response of a predator to an increase in prey density specifically refers to:
(A) The change in predator population size through reproduction or aggregation.
(B) The increase in the number of prey consumed per individual predator.
(C) The evolutionary shift in predator body size over multiple generations.
(D) The ratio of male to female predators in the localized area.

2018

39. An insect species' fundamental niche differs from its realized niche in that the fundamental niche is:
(A) The specific host plant selected by females for oviposition.

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(B) The theoretical range of resources a species can utilize without biotic constraints.
(C) The restricted ecological role a species plays due to competition and predation pressures.
(D) The physical geographical area where the insect was originally discovered.

2019

40. Determine the correct order of the following ecological levels of organization, from the least inclusive to the most inclusive:
I. Population
II. Biosphere
III. Organism
IV. Ecosystem
V. Community
(A) III, I, V, IV, II
(B) I, III, V, IV, II
(C) III, V, I, II, IV
(D) I, V, III, IV, II

2008

41. Which sequence represents the correct chronological stages of a generalized primary succession leading to a stable climax community?
I. Establishment of herbaceous plants and grasses.
II. Colonization by pioneer lichen and moss species.
III. Development of a mature, stable forest ecosystem (climax community).
IV. Growth of shrubs and shade-intolerant pioneer trees.
(A) II, I, IV, III
(B) I, II, IV, III
(C) II, IV, I, III
(D) IV, I, II, III

2015

42. When two species exhibit significant niche overlap in an agroecosystem, what is the most likely immediate ecological consequence?
(A) A mutualistic relationship will immediately form to share the resource.
(B) Both species will exponentially increase their carrying capacities.
(C) Local predator populations decline due to increased confusion in prey selection.
(D) High interspecific competition leading to competitive exclusion or niche divergence.

2016

43. Which of the following relationships correctly exemplifies amensalism in an ecological community?
(A) A parasitoid wasp developing inside a caterpillar, eventually leading to its death.
(B) Aphids providing honeydew to ants in exchange for protection.
(C) Two herbivore species competing for the same leaf tissue.
(D) One insect inhibiting fungal growth via chemicals while remaining unaffected itself.

2024

44. Antibiosis in the context of plant-insect interactions is best classified as a mechanism of:
(A) Ecological mutualism.
(B) Commensalism where the insect benefits without harming the plant.
(C) Host plant resistance where the plant adversely affects the biology of the insect.
(D) A numerical response by predators to herbivore density.

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2011

45. The following question consists of two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): Commensalism is a common interspecific interaction where one insect species benefits while the host is neither helped nor harmed.
Reason (R): In all commensal relationships, the benefiting species eventually evolves into an obligate parasite.
Select the correct answer from the options below:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2013

46. In the construction of a standard cohort life table, the parameter d_x represents:
(A) The number of individuals surviving to the beginning of age interval x.
(B) The rate of mortality during age interval x.
(C) The life expectancy of individuals at age x.
(D) The number of individuals dying during age interval x.

2003

47. Which mathematical relationship correctly defines the mortality rate (q_x) in a life table?
(A) $q_x = \frac{d_x}{l_x}$
(B) $q_x = l_x - d_x$

(C) $q_x = \frac{L_x}{T_x}$

(D) $q_x = e_x \times d_x$

2012

48. Consider the following statements regarding survivorship curves:

I. A Type I curve shows low early mortality, with most individuals dying at an older age.

II. A Type II curve indicates a constant rate of mortality across all age groups.

III. A Type III curve is characterized by extremely high mortality in early life stages.

IV. Most highly fecund insects, like mosquitoes, exhibit a Type I survivorship curve.

Identify the correct combination of statements.

(A) I, II, and III

(B) I and III

(C) II, III, and IV

(D) I, II, and IV

2012

49. The primary objective of conducting a "key factor analysis" (e.g., Varley and Gradwell method) using ecological life tables is to:

(A) To identify the specific mortality factor driving intergenerational population fluctuations.

(B) Determining the exact chronological age of the oldest reproducing female in the population.

(C) Calculate the optimal photoperiod required to break obligate diapause.

(D) Assess the genetic mutation rate within a closed population.

2006

50. Generation mortality (K), used in key factor analysis, is calculated by summing the k-values of successive developmental stages. How is an individual stage k-value calculated mathematically?

(A) $k = \log(N_n) + \log(N_{n+1})$

(B) $k = \frac{N_n}{N_{n+1}}$

(C) $k = (N_n - N_{n+1}) \times 100$

(D) $k = \log(N_n) - \log(N_{n+1})$

2013

51. Which of the following is an EXCEPTION to the methods classified as absolute population sampling?

(A) Counting the number of moths captured per night in a light trap.

(B) Extensively counting all insects within a standardized $1m^2$ soil quadrat.

(C) Exhaustive vacuum sampling of a known volume of crop canopy using a D-vac.

(D) Taking standardized soil cores to extract and count all wireworms present.

2012

52. The Lincoln-Petersen Index ($N = \frac{M \times C}{R}$) is a fundamental formula used in which population estimation technique?

(A) Nearest-neighbor spatial analysis

(B) Sweep net relative estimation

(C) AESA visual sampling

(D) Mark-release-recapture

2007

53. If a researcher marks 100 beetles and releases them, and later recaptures 100 beetles of which 20 are marked, what is the estimated total population size (N) according to the Lincoln Index?

(A) 200

(B) 400

(C) 500

(D) 1000

2008

54. Which of the following explains why relative sampling methods (e.g., pitfall traps, sweep nets) can sometimes yield misleading population estimates?

(A) They inherently capture every single individual in the localized environment.

(B) They are mathematically complex and require destructive sampling of the host plant tissue.

(C) Efficiency varies with weather, time of day, and insect activity levels.

(D) They cannot be deployed in modern agroecosystems due to spatial constraints.

2008

55. Match the trapping mechanisms in List I with their primary targeted insect behavior or cue in List II.

List I: (Trapping Mechanisms)

P. Pheromone trap

Q. Light trap

R. Sticky trap (yellow)

S. Pitfall trap

List II: (Targeted Insect Behavior or Cue)

1. Attraction to specific visual color spectra (e.g., foliage mimicry).

2. Interception of epigeal (ground-dwelling) cursorial movement.

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3. Attraction via species-specific volatile chemical communication.
4. Positive phototaxis exhibited by nocturnal flying insects.

(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-1, Q-4, R-3, S-2

2025

56. What is the fundamental difference between empirical and mechanistic models in pest forecasting?
(A) Empirical models use historical correlations, while mechanistic models simulate biological processes.
(B) Empirical models only forecast predator populations, while mechanistic models focus on pests.
(C) Empirical models are primarily used for short-term daily forecasts, whereas mechanistic models cannot be used for forecasting.
(D) Mechanistic models require no biological data to construct.

2011

57. Which environmental variable is most universally integrated into short-term empirical pest forecasting models due to its overriding influence on insect phenology?
(A) Soil pH
(B) Annual tectonic shifts
(C) Lunar cycles
(D) Daily temperature (degree-days)

2016

58. An unprecedented, widespread, and explosive increase in an insect pest population, causing severe economic damage across a large geographical area, is formally termed:
(A) An epidemic or outbreak
(B) An endemic occurrence
(C) A latent population shift
(D) A secondary succession event

2008

59. The phenomenon of "pesticide-induced resurgence" is most directly caused by which ecological disruption?
(A) The application of sub-lethal doses that genetically improve the pest's reproductive system.
(B) The disproportionate mortality of natural enemy populations compared to the target pest population.
(C) The chemical transformation of the pesticide into an insect aggregation pheromone.
(D) The immediate shift of the pest from a K-selected to an r-selected reproductive strategy.

2019

60. Consider the following statements regarding pest outbreaks:
I. Secondary pest outbreaks occur when a previously minor pest erupts after the primary pest is controlled, often due to natural enemy destruction.
II. Monoculture agriculture severely restricts the likelihood of pest outbreaks due to increased crop resistance.
III. Climate change, specifically elevated winter temperatures, can increase overwintering survival and exacerbate outbreaks.
Identify the correct combination of statements.
(A) I and II
(B) I and III
(C) II and III
(D) I

2011

61. Habitat fragmentation in modern agricultural landscapes typically impacts insect ecology by:
(A) Reducing biodiversity and isolating populations, which can hinder the natural control of pests.
(B) Increasing the continuous dispersal efficiency of all natural enemies equally.
(C) Providing unlimited carrying capacity for specialized native predators.
(D) Completely eliminating the edge effect in crop borders.

2014

62. Which agricultural practice is specifically designed to disrupt the spatial and temporal continuity of a pest's food supply, thereby reducing population buildup?
(A) Monocropping
(B) Intensive deep tillage
(C) Crop rotation
(D) Application of broad-spectrum insecticides

2013

63. How does deep summer tillage physically function as an ecological pest management strategy against certain soil-dwelling insects?
(A) It provides a dense layer of organic matter that traps emerging adults.
(B) It chemically alters the soil pH, creating an

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antibiotic environment.
(C) It increases the soil moisture levels uniformly, preventing the onset of facultative diapause.
(D) Exposure of overwintering pupae to lethal desiccation, heat, and predators.

2015

64. A synecological study of an agricultural field would focus primarily on:
(A) The thermal developmental threshold of a single aphid species.
(B) Detailed study of mating and oviposition behavior of a specific lepidopteran pest species.
(C) Analysis of interactions between multiple herbivore species, host plants, and natural enemies.
(D) The physiological changes in an insect's hemolymph during overwintering.

2014

65. The concept of "Time-specific" or "Static" life tables is best characterized by:
(A) Following a single generation of individuals from birth until the very last individual dies.
(B) Sampling a population at one specific point in time to determine the age distribution of individuals currently alive.
(C) Recording only the time it takes for an insect to complete its pupal stage under varying temperatures.
(D) Monitoring the exact time of day that peak adult emergence occurs over a season.

2024

66. Which mathematical expression best describes the Shannon-Wiener diversity index (H')?
(A) $H' = -\sum(p_i \ln p_i)$
(B) $H' = \dfrac{\sum(n_i(n_i-1))}{N(N-1)}$
(C) $H' = \dfrac{S}{\sqrt{N}}$
(D) $H' = \dfrac{\ln(S)}{\ln(N)}$

2003

67. The Simpson's Diversity Index ($D = \sum p_i^2$) primarily emphasizes which community attribute compared to the Shannon-Wiener index?
(A) Rare species richness
(B) The absolute physical size of the habitat
(C) The trophic efficiency of the apex predator
(D) The dominance of the most abundant species

2004

68. Which statement regarding the ecological impact of polyculture (mixed cropping) is INCORRECT?
(A) It generally increases the diversity and abundance of natural enemies.
(B) It creates a more complex microclimate that can be unfavorable for specific pest outbreaks.
(C) It reliably guarantees the complete eradication of all polyphagous insect pests.
(D) It makes host location by specialized herbivores more difficult due to visual and olfactory camouflage.

2017

69. The following question consists of two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): The realized niche of an insect species is typically narrower than its fundamental niche.
Reason (R): In natural environments, interspecific competition, predation, and disease limit the actual conditions and resources a species can exploit.
Select the correct answer from the options below:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

NODIA

2019

70. Consider the following statements regarding insect dispersal:
I. Dispersal is always a strictly unidirectional movement with no return journey.
II. Migration is distinct from routine dispersal as it involves persistent, straightened-out movement and temporary suppression of station-keeping responses.
III. Phoresy is a form of active, energy-intensive flight dispersal.
IV. Dispersal helps alleviate localized intraspecific competition and prevents inbreeding.
Identify the INCORRECT combination of statements.
(A) I and III
(B) II, III, and IV
(C) I and II
(D) I, III, and IV

2008

71. The "competitive release" phenomenon occurs in an ecosystem when:
(A) The removal of a strong competitor, allowing a suppressed species to expand its realized niche.
(B) Two species evolve identical fundamental niches to share a superabundant resource.
(C) A predator population outgrows its prey and turns to cannibalism.
(D) An insect species artificially increasing the total carrying capacity of its environment.

2011

72. In comparing age-specific (cohort) and time-specific (static) life tables, what is the primary logistical advantage of a time-specific life table?
(A) Requires only a single sampling event to capture age structure snapshots, saving time.
(B) Precisely tracking every individual's specific cause of death over the entire season.
(C) It entirely eliminates the need to identify the insect species.
(D) It inherently calculates the exact rate of migration in and out of the habitat.

2017

73. Which of the following defines "hibernation" in the context of insect ecology?
(A) A state of summer dormancy triggered by extreme heat and drought.
(B) Arrested development and reduced metabolism to survive winter or low temperatures.
(C) A form of obligate diapause occurring exclusively within specific tropical environments.
(D) The daily period of rest taken by diurnal insects during the night.

2005

74. Aestivation is an ecological adaptation primarily designed to help insects survive which specific environmental conditions?
(A) High temperatures, aridity, and resource scarcity during summer months.
(B) Extreme winter freezing and short photoperiods.
(C) Flooding and saturated soil conditions during monsoon seasons.
(D) Severe interspecific competition in climax forest communities.

2013

75. A common hormonal trigger for the initiation of diapause in insects involves the altered secretion of which major endocrine component?
(A) A complete absence of ecdysone with no change in other hormones.
(B) The massive overproduction of juvenile hormone specifically during the adult stage of life.
(C) The release of alarm pheromones into the hemolymph.
(D) Shutdown of prothoracicotropic hormone (PTTH), preventing subsequent molting cycles.

2013

76. In an ecosystem, which group occupies the first trophic level?
(A) Primary producers (Autotrophs)
(B) Primary consumers (Herbivores)
(C) Secondary consumers (Predators)
(D) Decomposers (Detritivores)

2005

77. Which concept correctly characterizes a "food web" as opposed to a "food chain"?
(A) A food web is a linear sequence of energy transfer, while a food chain branches infinitely.
(B) A food web only includes predators and parasitoids, ignoring primary producers.
(C) A food web assuming 100% efficient energy transfer across all trophic levels.
(D) Represents the complex, interconnected feeding pathways present in a real ecosystem.

2010

78. When analyzing energy flow through trophic levels, the term "assimilation efficiency" refers specifically to:
(A) Percentage of ingested energy absorbed across the gut wall rather than egested as frass.
(B) The percentage of absorbed energy that is converted directly into new insect body biomass.
(C) The total amount of solar radiation captured by the host plant.
(D) The rate at which an insect population reaches carrying capacity.

2024

79. Which of the following is an EXCEPTION to the density-dependent factors that naturally regulate insect populations?
(A) Intraspecific competition for food resources.

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(B) A sudden, unseasonal hard frost that kills 90% of exposed larvae.
(C) The spread of an entomopathogenic virus within a dense larval cluster.
(D) An increase in parasitoid aggregation in patches of high host density.

2004

80. Match the ecological statistical distributions in List I with their corresponding spatial patterns in List II.
List I: (Ecological Statistical Distributions)
P. Poisson distribution
Q. Positive Binomial distribution
R. Negative Binomial distribution
S. Normal distribution (continuous)
List II: (Spatial Patterns)
1. Aggregated or clumped spatial pattern.
2. Random spatial pattern where variance equals mean.
3. Uniform or regular spatial pattern where variance is less than mean.
4. Symmetrical, bell-shaped continuous data distribution.
(A) P-2, Q-3, R-1, S-4
(B) P-3, Q-1, R-2, S-4
(C) P-1, Q-4, R-3, S-2
(D) P-2, Q-1, R-3, S-4

2021

81. Consider the following statements regarding sampling techniques:
I. Pitfall traps provide an absolute population density per square meter for ground beetles.
II. Suction traps are highly effective for sampling small, flying insects like aphids to estimate aerial density.
III. Sweep netting provides a relative estimate that can be standardized by taking a fixed number of sweeps.
IV. Light traps capture a random, unbiased sample of all insect species present in an ecosystem.
Identify the INCORRECT combination of statements.
(A) I and IV
(B) I and II
(C) II and III
(D) I, III, and IV

2001

82. Which environmental condition is the primary driver of the geographical separation denoted by Wallace's Line?
(A) Severe differences in average annual rainfall.
(B) An abrupt shift in soil pH across the Indonesian archipelago.
(C) It was caused by the historical application of massive quantities of various organochlorine pesticides.
(D) Deep-water trenches that prevented land bridge formation during Pleistocene glaciations.

2013

83. The competitive exclusion principle is most closely associated with the early experimental work utilizing Paramecium species conducted by:
(A) G.F. Gause
(B) Charles Darwin
(C) A.J. Nicholson
(D) V. Volterra

2022

84. Which of the following describes the most relevant application of knowledge concerning insect spatial distribution in agricultural pest management?
(A) Strictly determining the taxonomic family of the pest species found in the field.
(B) To genetically modify the host plant to resist drought.
(C) Designing statistically robust and cost-effective field scouting and sampling protocols.
(D) To accurately predict global climate change models.

2005

85. The following question consists of two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): The logistic growth curve initially resembles an exponential curve but eventually forms an asymptote.
Reason (R): As population density increases, environmental resistance restricts the growth rate until it balances out at the carrying capacity (K).
Select the correct answer from the options below:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

NODIA

2006

86. In the context of life tables, the parameter e_x defines the:

(A) Explicit mortality risk at age x.
(B) The estimated number of eggs produced by a single reproductive female at age x.
(C) Life expectancy, or average time units an individual of age x has left to live.
(D) The total energy extracted by a predator from prey age x.

2011

87. A life table generated for an insect species reveals that mortality is extremely high during the egg and early larval stages, but surviving adults live for a long and stable period. Which survivorship curve does this represent?
(A) Type I
(B) Type II
(C) Type IV
(D) Type III

2011

88. Which of the following correctly pairs an ecosystem dynamic concept with its definition?
(A) Ecotone : The transition zone between two distinct ecological communities.
(B) Secondary succession : The initial colonization of bare rock by lichens.
(C) Climax community : A highly unstable pioneer community prone to rapid species turnover.
(D) Trophic cascade : The upward flow of nutrients from decomposers strictly to apex predators.

2012

89. In a well-functioning natural ecosystem, ecological succession ultimately trends toward:
(A) A state of maximum thermodynamic entropy and zero total biological biomass.
(B) A diverse, stable climax community with complex interspecific interactions.
(C) A monoculture environment dominated by a single highly aggressive r-selected species.
(D) The complete elimination of all autotrophic organisms.

2013

90. Which of the following is an EXCEPTION to the typical attributes of an r-selected species?
(A) Rapid development
(B) High dispersal capability
(C) Large brood sizes and high reproductive output.
(D) Iteroparity (multiple reproductive cycles over a long life).

2009

91. Determine the correct sequence of steps involved in standard Agro-Ecosystem Analysis (AESA) decision-making in the field:
I. Analysis of the collected data including pest-defender ratios and plant compensation.
II. Taking field observations (sampling pests, natural enemies, plant health, weather).
III. Implementation of the finalized pest management decision.
IV. Group discussion and drawing of the AESA chart.
(A) II, IV, I, III
(B) I, II, IV, III
(C) II, I, IV, III
(D) IV, II, I, III

2013

92. The phenomenon where a parasite itself is parasitized by another distinct species of parasite is formally defined as:
(A) Hyperparasitism
(B) Superparasitism
(C) Multiparasitism
(D) Cleptoparasitism

2024

93. Superparasitism differs ecologically from multiparasitism in that superparasitism involves:
(A) Multiple species of parasitoids attacking a single host simultaneously.
(B) A parasitoid acting exclusively as a predator during its adult stage.
(C) A parasitoid feeding on the host tissue externally without eventually killing it.
(D) More individuals of one species developing in a host than the host can support.

2012

94. The interaction where two or more species share a limiting resource and suffer reduced fitness as a result is known as:
(A) Competition
(B) Predation
(C) Commensalism
(D) Mutualism

2012

95. In an experiment, an ecologist models the population dynamics of two competing species using the Lotka-Volterra competition equations. The competition coefficients α and β specifically represent:
(A) The intrinsic rates of natural increase for each species.
(B) The carrying capacities of the environment

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for each species.
(C) The per capita effect of one species on the population growth of the other species.
(D) The mortality rates induced strictly by abiotic environmental factors.

2024

96. Which statement INCORRECTLY explains the mechanisms behind secondary pest outbreaks?
(A) They frequently occur following the application of broad-spectrum insecticides.
(B) They are triggered by the selective elimination of the secondary pest's natural enemies.
(C) They arise because the secondary pest is inherently more susceptible to the applied insecticide than the primary pest.
(D) They result in a previously economically insignificant insect becoming a major damaging pest.

2022

97. What is the fundamental ecological purpose of a "refuge" in modern resistance management and pest ecology?
(A) To provide an area where natural enemies can completely eradicate all pest genotypes.
(B) To maintain a sub-population of susceptible pests to mate with resistant individuals, delaying the evolution of widespread resistance.
(C) To permanently house diapausing insects in a state of suspended animation.
(D) To concentrate pesticide applications in one small, highly toxic area.

2025

98. Consider the following statements regarding ecological niche concepts:
I. Niche overlap inevitably leads to immediate extinction of one species.
II. The fundamental niche is derived from laboratory observations in the absence of competitors.
III. Habitat describes "where" an insect lives, while niche describes "how" it makes a living.
IV. Resource partitioning allows sympatric species to reduce niche overlap and coexist.
V. Gause's Law applies heavily to competitive exclusion in completely distinct niches.
Identify the INCORRECT combination of statements.
(A) I and V
(B) II, III, and IV
(C) I, II, and V
(D) III and IV

2001

99. A mutualistic relationship is best demonstrated by which of the following insect examples?
(A) A braconid wasp larva feeding on the internal fluids of a tomato hornworm.
(B) Termites relying on gut protozoa and bacteria to digest cellulose.
(C) A monarch butterfly caterpillar sequestering toxins from milkweed for its own defense.
(D) A praying mantis capturing and consuming a honey bee.

2012

100. Which physical factor primarily drives the seasonal migration patterns observed in species like the Monarch butterfly?
(A) Sudden shifts in soil pH.
(B) A rapid transition from exponential to logistic population growth.
(C) The accumulation of sub-lethal pesticide residues within the caterpillar's body.
(D) Seasonal changes in temperature, photoperiod, and host plant availability.

2011

101. The concept of "carrying capacity" (K) is dynamic and can fluctuate over time. Which of the following events would most likely result in an immediate decrease in the carrying capacity for an herbivorous insect in an agroecosystem?
(A) An application of a highly specific synthetic aggregation pheromone.
(B) Severe drought causing widespread wilting and nutritional decline of the host crop.
(C) The extermination of all top-tier predators in the region.
(D) The insect entering a state of facultative diapause.

2022

102. Which metric provides the most accurate reflection of species evenness in an ecological community?
(A) The absolute count of species present.
(B) The calculation of Pielou's evenness index ($J' = \frac{H'}{\ln S}$).
(C) The variance-to-mean ratio of spatial distribution.
(D) The biotic potential of the dominant species.

NODIA

2025

103. In insect ecology, what is the primary distinction between absolute density and relative density population estimates?

(A) Absolute density measures insects per unit area/volume; relative density uses sampling units.

(B) Absolute density applies only to adult stages, while relative density is restricted to larval stages.

(C) Absolute density utilizes theoretical models, while relative density relies strictly on field collections.

(D) Absolute density is always a fraction, while relative density is a whole number.

2024

104. Match the ecological life table parameters in List I with their appropriate mathematical derivation or meaning in List II.

List I: (Ecological Life Table Parameters)

P. l_x

Q. d_x

R. q_x

S. S_x

List II: (Mathematical Derivation or Meaning)

1. Mortality rate ($\frac{d_x}{l_x}$).
2. Proportion surviving to the beginning of age x.
3. Survival rate $(1 - q_x)$.
4. Number dying during age interval x.

(A) P-2, Q-4, R-1, S-3

(B) P-4, Q-2, R-3, S-1

(C) P-1, Q-3, R-2, S-4

(D) P-2, Q-1, R-4, S-3

2006

105. The following question consists of two statements, one labeled as Assertion (A) and the other as Reason (R).

Assertion (A): Natural ecosystems generally exhibit higher ecological stability than large-scale agricultural monocultures.

Reason (R): Natural ecosystems possess high biodiversity and complex, overlapping food webs that buffer against environmental disturbances and pest outbreaks.

Select the correct answer from the options below:

(A) Both A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is not the correct explanation of A.

(C) A is true but R is false.

(D) A is false but R is true.

2009

106. Which of the following is an EXCEPTION to the characteristics of a stable climax community?

(A) High species diversity.

(B) Complex food webs and intricate spatial structures.

(C) A continuous, rapid turnover of dominant plant and insect species.

(D) High efficiency in energy utilization and nutrient cycling.

2015

107. The fundamental equation $N_t = N_0 e^{\{rt\}}$ mathematically models which ecological phenomenon?

(A) Competitive exclusion.

(B) Exponential population growth in an unlimited environment.

(C) Logistic population growth.

(D) The numerical response of a predator.

2002

108. Which of the following correctly describes a limitation of using purely empirical models for long-term pest forecasting?

(A) They require a complete, molecular-level understanding of insect genetics.

(B) They are consistently more computationally intensive than biological mechanistic models.

(C) Failure if conditions drift outside historical data ranges used for calibration.

(D) They cannot incorporate temperature data in any form.

2007

109. What is the most likely ecological effect of removing the top-tier predators (apex predators) from a multi-trophic terrestrial ecosystem?

(A) Mesopredator release, potentially leading to over-exploitation of primary consumers.

(B) Primary producers will immediately increase their carrying capacity.

(C) A permanent and significant decrease in the overall rate of secondary succession.

(D) The immediate onset of an obligate diapause in all herbivorous species.

2012

110. Consider the following statements regarding insect population monitoring:

I. Mark-release-recapture is most accurate for closed populations with minimal immigration/emigration.

II. Sticky traps using yellow hues specifically

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target the positive phototaxis of nocturnal moths.

III. Sweep netting provides a highly consistent absolute estimate regardless of operator technique.

IV. Quadrat sampling is well-suited for relatively immobile insects or soil fauna.

Identify the INCORRECT combination of statements.

(A) II and III
(B) I and IV
(C) I, II, and IV
(D) III and IV

2006

111. Which factor represents the most critical driver of density-dependent mortality in natural insect populations?

(A) Extreme unseasonal temperature fluctuations.
(B) Intraspecific competition for limited host plant resources.
(C) Broad-scale natural disasters such as volcanic eruptions.
(D) The lunar cycle's influence on nocturnal light levels.

2006

112. In the context of energy dynamics, ecological efficiency is mathematically defined as:

(A) Ratio of energy passed to next trophic level divided by energy from the previous.
(B) The total amount of biomass produced divided by the time taken for its production.
(C) The total solar energy striking the ecosystem divided by the energy utilized by herbivores.
(D) The rate of metabolism during diapause.

2006

113. An ecologist compares a mature forest (natural ecosystem) to a continuously tilled wheat field (agroecosystem). Which of the following metrics will likely be significantly higher in the wheat field?

(A) Structural complexity and microhabitat availability.
(B) Species richness and gamma diversity.
(C) The proportion of r-selected, highly dispersive herbivore species.
(D) The stability of inter-annual predator-prey cycles.

2008

114. The term "quiescence" in insect ecology refers to:

(A) A genetically programmed, obligatory state of suspended animation triggered by photoperiod length.
(B) The permanent cessation of feeding observed in adult ephemeropterans (mayflies).
(C) The active state of physiological preparation prior to migration.
(D) Temporary, direct halt in development due to adverse conditions, reversing immediately.

2006

115. Which of the following INCORRECTLY pairs an ecological concept with its application in Agricultural Entomology?

(A) Economic threshold : Deciding the precise moment when control actions are justified to prevent economic loss.
(B) Degree-days : Timing the application of targeted insecticides against specific vulnerable larval instars.
(C) Competitive exclusion : Releasing a hyperparasitoid to exclusively protect the primary pest.
(D) Habitat management : Planting nectar-rich border crops to enhance parasitoid survival and efficacy.

2021

116. The concept of "Environmental Resistance" includes all of the following factors EXCEPT:

(A) Natural enemies (predators, parasitoids, pathogens).
(B) Adverse climatic conditions (extreme heat, cold, drought).
(C) Shortages in food or breeding sites.
(D) The insect's inherent maximum fecundity ($r_{\max}$).

2008

117. In studying insect dispersal, "boundary layer" refers to:

(A) Air layer near ground where wind is slower than flight speed, allowing directional control.
(B) The physical barrier formed by a mountain range.
(C) The distinct transition zone between two different crop types within an agroecosystem.
(D) The outermost waxy layer of the insect epicuticle preventing desiccation during flight.

NODIA

2010

118. The following question consists of two statements, one labeled as Assertion (A) and the other as Reason (R).

Assertion (A): The widespread adoption of continuous monoculture over vast areas increases the probability of severe pest outbreaks.

Reason (R): Monocultures provide an unlimited, uniform, and easily accessible food supply for specialized herbivores, while lacking the microhabitats necessary to sustain robust natural enemy populations.

Select the correct answer from the options below:

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2014

119. Which statistical index uses the formula $1 - \sum \frac{n_i(n_i-1)}{N(N-1)}$ to express biodiversity?

(A) Shannon-Wiener Index
(B) Simpson's Index of Diversity (1 - D)
(C) Margalef's Richness Index
(D) Sorensen's Similarity Coefficient

2019

120. When analyzing the age structure of a localized insect population, a significantly wide base on an age pyramid (a vast majority of individuals in the egg and early larval stages) strongly suggests:

(A) A declining population suffering from intense competitive exclusion.
(B) A rapidly growing population experiencing exponential increase.
(C) A stable population at carrying capacity.
(D) A population entirely composed of post-reproductive individuals.

2012

121. Consider the following statements regarding the impact of climate change on insect ecology:

I. Elevated atmospheric CO_2 frequently lowers the nitrogen content of host plants, potentially forcing herbivores to consume more plant tissue to meet nutritional needs.
II. Warmer global temperatures uniformly decrease the number of generations per year for all multivoltine insects.
III. Range expansions toward higher latitudes and altitudes are frequently observed in pest species as climatic conditions warm.
IV. Phenological mismatches may occur if a pest emerges earlier than its host plant or specialized parasitoids.

Identify the correct combination of statements.

(A) I, III, and IV
(B) I, II, and III
(C) II, III, and IV
(D) I and IV

2007

122. Which concept is most relevant in explaining why two closely related species of sympatric beetles might feed on the exact same host plant but at entirely different times of the year?

(A) Temporal resource partitioning
(B) Trophic cascading
(C) Biomagnification
(D) The 10% energy rule

2019

123. The total amount of solar energy converted into chemical energy by autotrophs during a given time period in an ecosystem is technically defined as:

(A) Net Primary Productivity (NPP)
(B) Secondary Productivity
(C) Assimilation capacity
(D) Gross Primary Productivity (GPP)

2018

124. Match the specific types of parasitoids in List I with their ecological behavior in List II.

List I: (Types of Parasitoids)

P. Idiobiont parasitoid
Q. Koinobiont parasitoid
R. Solitary parasitoid
S. Gregarious parasitoid

List II: (Ecological Behavior)

1. Allows the host to continue growing and developing after parasitization.
2. Paralyzes or kills the host immediately, arresting its further development.
3. Only a single parasitoid larva develops within or on a single host.
4. Multiple parasitoid larvae develop simultaneously within or on a single host.

(A) P-2, Q-1, R-3, S-4
(B) P-1, Q-2, R-3, S-4
(C) P-2, Q-1, R-4, S-3
(D) P-1, Q-2, R-4, S-3

2013

125. In the calculation of thermal constants (degree-days), the biofix date refers to:

(A) A biological event, like first pheromone trap

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catch, used to start DD accumulation.
(B) The date on which the first heavy frost occurs in autumn.
(C) The theoretical date when a population achieves its carrying capacity.
(D) The exact date a specific pesticide application degrades completely in the environment.

2011

126. A forecaster wishes to build a long-term empirical model to predict grasshopper outbreaks next summer. Which variable is traditionally most predictive in such statistical models?
(A) The phase of the moon during the previous winter.
(B) Large-scale climate variables from preceding seasons, such as rainfall patterns.
(C) The precise daily temperature fluctuations recorded exactly one week before the outbreak occurs.
(D) The instantaneous wind speed during adult swarming flight.

2001

127. Which ecological scenario provides the best example of a "numerical response" by a predator population?
(A) A lady beetle consuming 50 aphids per day instead of 20 due to increased aphid density.
(B) A bird learning to selectively ignore brightly colored, toxic caterpillars in a patch.
(C) A predator shifting its foraging time from day to night to avoid extreme heat.
(D) Localized increase in predator density following an influx of migratory species.

2024

128. Arrange the following spatial patterns in order of increasing variance-to-mean ($\frac{V}{M}$) ratios:
I. Clumped (Aggregated)
II. Uniform (Regular)
III. Random
(A) II, III, I
(B) I, III, II
(C) III, II, I
(D) II, I, III

2025

129. What is the fundamental mechanism underlying the success of "push-pull" habitat management strategies in agroecosystems?
(A) The simultaneous deployment of lethal systemic insecticides and sterile insect releases.
(B) Pushing water into the field to drown larvae and pulling water out to desiccate soil pupae.
(C) Utilizing extreme high and low frequencies of sound waves to disrupt mating.
(D) Repelling pests from crops using intercrops and attracting them to trap crops.

2013

130. A highly skewed sex ratio favoring females in an insect population generally results in:
(A) Enhanced biotic potential and faster growth rate, assuming males fertilize multiple females.
(B) A rapid decline in the intrinsic rate of increase (r).
(C) The immediate transition to obligate parthenogenesis in all known insect species.
(D) A lower overall carrying capacity for the population.

2024

131. Determine the correct sequence of trophic energy transfer in a generalized terrestrial ecosystem:
I. Primary Consumer
II. Tertiary Consumer
III. Primary Producer
IV. Secondary Consumer
(A) III, I, IV, II
(B) I, III, II, IV
(C) III, IV, I, II
(D) IV, II, I, III

2006

132. The concept of "Allee effects" in population ecology dictates that:
(A) Population growth rates always remain constant regardless of density.
(B) Predators will always migrate away from high-density prey patches.
(C) Maximum reproductive success only occurs when the population vastly exceeds carrying capacity.
(D) Reduced fitness at very low densities due to difficulties in finding mates.

2015

133. Which of the following correctly pairs an insect sampling device with its operational mechanism?
(A) Berlese funnel : Utilizes a heat and desiccation gradient to drive soil microarthropods downward into a collecting vial.
(B) Malaise trap : Utilizes species-specific pheromones to lure heavily-armored ground beetles into a pit.
(C) D-vac : Utilizes a high-powered suction fan to collect insects from the plant canopy into

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a net.
(D) Sweep net : Extracts insects exclusively from within the cambium layer of woody stems.

2021

134. Which ecological index specifically quantifies the amount of species turnover along an environmental gradient (e.g., measuring how species composition changes as you move up a mountain)?
(A) Alpha diversity
(B) Gamma diversity
(C) Simpson's dominance index
(D) Beta diversity

2014

135. Consider the following statements regarding population growth:
I. The parameter r is maximized in stable, resource-limited climax environments.
II. Emigration is a demographic process that subtracts from the local population size.
III. The exponential growth model inherently assumes no environmental limitations or resource depletion.
IV. K-selected species generally devote massive amounts of energy to producing large numbers of tiny offspring.
Identify the INCORRECT combination of statements.
(A) I and IV
(B) II and III
(C) I, III, and IV
(D) II and IV

2005

136. Which statement best encapsulates the ecological principle behind crop rotation as a cultural pest control method?
(A) It permanently sterilizes the soil of all microorganisms.
(B) Genetically altering the fundamental niche of various polyphagous predators in the area.
(C) It prevents the wind-assisted dispersal of migratory adult insects.
(D) Disrupting life cycles of specialized pests by removing host plants in alternate years.

2013

137. Which of the following is an EXCEPTION to the mechanisms by which a non-pest insect might rapidly become a major agricultural pest?
(A) An extensive genetic bottleneck that drastically reduces the species' adaptive diversity.
(B) The introduction of the insect into a new geographical realm devoid of its native natural enemies.
(C) The widespread cultivation of a highly susceptible, genetically uniform crop variety across vast areas.
(D) The intensive application of a non-target insecticide that decimates the localized predator guild.

2001

138. The Lotka-Volterra predator-prey model mathematically predicts which specific long-term population dynamic in a simplified environment?
(A) Continuous exponential growth of both predator and prey.
(B) Coupled oscillations where predator abundance lags slightly behind prey abundance.
(C) Immediate extinction of both species within one generation.
(D) A permanent static equilibrium where neither population fluctuates by even a single individual.

NODIA

2012

139. In the context of life table analysis, the generation survival rate is equal to:
(A) Product of the stage-specific survival rates across all developmental stages.
(B) The sum of the stage-specific survival rates.
(C) The average number of eggs laid multiplied by the total number of females present.
(D) The total number of adults squared.

2024

140. Which of the following represents the most scientifically accurate approach to validating an empirical pest forecasting model before wide-scale deployment?
(A) Testing the model's predictions exclusively against the identical historical dataset used to originally calibrate it.
(B) Comparing the model's predictions against independent, newly collected field data from different years or geographical locations.
(C) Ensuring the model outputs align perfectly with qualitative farmer anecdotes from decades prior.
(D) Discarding any field data that contradicts the model's initial predictions.

2001

141. The specific branch of ecology dealing with the complex interactions, energy flow, and nutrient cycling among multiple sympatric insect species and their environment is termed:
(A) Synecology
(B) Autecology
(C) Ethology
(D) Molecular phylogenetics

2018

142. The following question consists of two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): The calculation of alpha diversity is sufficient to completely understand the biodiversity of an entire, heterogeneous continent.
Reason (R): Alpha diversity measures only the species richness and evenness within a single, localized, homogenous habitat.
Select the correct answer from the options below:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2007

143. Consider the concept of "degree-days". If the minimum temperature for a given day is $15^{\circ}C$, the maximum is $25^{\circ}C$, and the insect's base developmental threshold is $10^{\circ}C$, how many degree-days are accumulated on that day using the standard averaging method?
(A) 5
(B) 10
(C) 15
(D) 20

2015

144. In ecosystem ecology, the ratio of variance to mean $(\frac{V}{M})$ is frequently utilized. A ratio significantly less than 1 $(V < M)$ strongly implies that the underlying insect population is responding to:
(A) A highly concentrated, localized food resource attracting massive aggregations.
(B) A completely homogenous environment with no direct interactions between individuals.
(C) The sudden onset of a secondary pest outbreak.
(D) Strong antagonistic interactions, such as territoriality, forcing even spacing.

2011

145. A researcher studying the zoogeography of an ancient insect lineage notes its presence strictly in South America, Africa, and Australia. This highly disjunct distribution is most classically explained by:
(A) The historical fragmentation of the supercontinent Gondwana.
(B) Recent human-mediated accidental transport across the Atlantic.
(C) High-altitude wind dispersal crossing the Pacific Ocean in a single generation.
(D) The competitive exclusion of the species in the Palearctic realm during the last century.

2008

146. Which of the following interactions best defines commensalism?
(A) Species A benefits, Species B is harmed.
(B) Species A benefits, Species B is entirely unaffected.
(C) Species A is harmed, Species B is entirely unaffected.
(D) Both Species A and Species B benefit significantly.

2021

147. Under which specific ecological conditions would r-selection naturally be favored over K-selection?
(A) An unpredictable, frequently disturbed, or newly formed ephemeral habitat.
(B) A highly stable, mature climax forest nearing carrying capacity.
(C) An environment with extremely intense interspecific competition and resource scarcity.
(D) A subterranean cave ecosystem with perfectly constant temperature and humidity.

2001

148. The transition from a fundamental niche to a realized niche is primarily mediated by which of the following?
(A) Random genetic drift over a single generation.
(B) The physical boundaries and barriers of distinct biogeographical realms.
(C) Biotic interactions like interspecific competition, predation, and parasitism.
(D) The abiotic accumulation of degree-days.

2004

149. The carrying capacity (K) of an agroecosystem for a specific pest species is primarily determined by:
(A) Maximum limits imposed by available food resources and environmental resistance.

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(B) The exact mathematical value of the species' intrinsic rate of increase ($r_{\max}$).
(C) The theoretical number of eggs a single female can physically produce in a vacuum.
(D) The historical evolutionary origin of the insect order.

2014

150. A life table provides all the necessary raw data to definitively calculate which of the following demographic parameters?
(A) The net reproductive rate (R_0) and generation time (T).
(B) The exact flight speed of the adult insect.
(C) The precise genetic mutation rate per base pair.
(D) The physiological supercooling point of the pupal stage.

2018

151. Which statement best describes the fundamental difference between a food chain and an ecological pyramid of energy?
(A) Chain traces single pathways; pyramid illustrates total energy at each trophic level.
(B) A food chain always includes decomposers, while a pyramid of energy explicitly excludes them.
(C) A food chain can be inverted, whereas a pyramid of energy is purely a theoretical construct.
(D) A food chain measures biomass, while a pyramid of energy measures purely spatial distribution.

2014

152. In an AESA (Agro-Ecosystem Analysis) evaluation, a favorable pest-to-defender (P:D) ratio (e.g., highly abundant natural enemies relative to pests) would most logically result in which management decision?
(A) Immediate application of a broad-spectrum chemical insecticide to eradicate both groups.
(B) Recommending massive nitrogen fertilizer applications to increase plant compensation.
(C) Mechanically plowing the entire field to initiate secondary succession.
(D) Avoiding chemical intervention to allow natural biocontrol to regulate the population.

2021

153. When comparing the ecological footprint of natural ecosystems versus agroecosystems, agroecosystems generally exhibit:
(A) Higher primary productivity for harvestable yield, but lower biodiversity and stability.
(B) Lower gross primary productivity but higher structural stability.
(C) Perfect internal nutrient cycling requiring no significant external industrial inputs.
(D) Complete resistance to non-native invasive species.

2008

154. Which phenomenon correctly characterizes "competitive displacement"?
(A) Two native species naturally evolving mutualistic traits over millennia to avoid competition.
(B) The seasonal migration of an entire population to track shifting temperature gradients.
(C) The physiological shift from obligate diapause to active development.
(D) Localized extinction following the introduction of a more efficient niche competitor.

NODIA

2008

155. Which of the following best exemplifies the application of the competitive exclusion principle in modern biological control?
(A) Introducing a harmless herbivore to outcompete a pest for identical resources.
(B) Applying a highly toxic systemic pesticide to clear the niche for beneficial insects.
(C) Utilizing light traps to monitor the emergence of noctuid moths.
(D) Calculating the theoretical constant of the target pest to predict its emergence.

2004

156. The Holling Type III functional response curve typically implies that the predator:
(A) Is easily overwhelmed and confused at extremely low prey densities, refusing to feed.
(B) Consumes prey at a linearly infinite rate regardless of the density of the prey patch.
(C) Can only feed on stationary, inanimate objects.
(D) Consumption lags at low prey densities due to search image lack, followed by a surge.

2025

157. An ecologist observing an insect population notes that mortality rates are heavily dependent on population density. Which factor is LEAST

likely responsible for this density-dependent mortality?

(A) An epizootic outbreak of an entomopathogenic fungus.
(B) Intense intraspecific competition for pupation sites.
(C) Increased attraction and aggregation of parasitoids to high-density patches.
(D) A catastrophic late-spring frost.

2013

158. In pest forecasting, what is the primary role of a "mechanistic model"?

(A) To strictly correlate historical trap catch data with historical crop damage using linear regression.
(B) Providing a qualitative, visual chart of predator colors for rapid field identification.
(C) To automatically deploy mechanical traps in the field.
(D) Simulating the actual biological processes driving the population dynamics.

2021

159. Consider the following statements regarding symbiosis:

I. Mutualism involves reciprocal benefits for both interacting species.
II. Amensalism occurs when one species is severely harmed while the other remains completely unaffected.
III. Endosymbionts like Buchnera in aphids provide essential amino acids, representing obligate mutualism.
IV. Commensalism inevitably evolves into intense interspecific competition.

Identify the correct combination of statements.

(A) I, II, and III
(B) I and III
(C) II, III, and IV
(D) I, II, and IV

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160. Which of the following scenarios best describes the ecological concept of a "trophic cascade"?

(A) Herbivores evolving resistance to a novel class of synthetic insecticides.
(B) A gradual increase in global temperatures shifting a pest's geographic range northward.
(C) The accumulation of toxic heavy metals as energy flows from primary consumers to apex predators.
(D) Top predator introduction reducing herbivores, allowing primary producers to flourish.

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ANSWERS

1. (A) The study of an individual insect species and its relationship with the surrounding environment.
Autecology focuses on the ecological requirements and behaviors of a single species throughout its life cycle. It examines how individual organisms interact with abiotic and biotic components of their specific environment. This approach is fundamental for understanding species distribution and physiological adaptations. It contrasts with synecology, which investigates complex interactions within multi-species biological communities.

2. (C) Habitat
The specific physical environment where an organism lives and finds necessary resources is defined as its habitat. It provides the essential abiotic conditions and biological requirements for survival, including food, water, and shelter. While a niche describes the functional role an organism plays within its community, the habitat represents the actual geographic or physical location.

3. (A) The integration of mathematical population dynamics emerged primarily in the late 20th century.
Mathematical population dynamics actually emerged much earlier than the late twentieth century, with foundational models developed in the nineteen-twenties and thirties. Early insect ecology relied heavily on observational natural history before transitioning into quantitative analysis. Synecology and the niche concept were also established early on to provide a structured framework for understanding community interactions and distributions.

4. (D) Thermal constant (degree-days)
Insects are poikilothermic organisms whose development depends on the accumulation of environmental heat. The thermal constant represents the total amount of heat, measured in degree-days, required for a species to complete a specific developmental stage. This metric is more accurate than chronological time because it accounts for temperature fluctuations that directly influence the rate of physiological processes.

5. (B) $DD = \frac{T_{\max} + T_{\min}}{2} - T_{base}$
Degree-day accumulation is traditionally calculated using the daily average temperature method. The maximum and minimum daily temperatures are averaged to estimate the mean temperature an insect experienced. The base developmental threshold, representing the temperature below which no growth occurs, is then subtracted from this mean. This formula provides a standardized way to track physiological progress toward maturity.

6. (C) A temporary cessation of growth and development known as quiescence.
Quiescence is a direct, non-programmed response to unfavorable environmental conditions like extreme cold. Unlike diapause, which is a genetically scheduled state of dormancy, quiescence begins immediately when conditions drop below a threshold and ends immediately when favorable conditions return. It allows insects to survive short-term fluctuations without committing to the physiological changes required for long-term dormancy or hibernation.

7. (D) Obligate diapause is genetically programmed to occur in every generation, whereas facultative diapause is environmentally induced.
Diapause is a physiological state of arrested development that helps insects survive seasonal stress. Obligate diapause is fixed within the genetic code and occurs in every individual of every generation, regardless of current conditions. In contrast, facultative diapause is optional and only triggered when specific environmental cues, such as changing photoperiod or temperature, signal approaching unfavorable conditions.

8. (A) Excessive heat leading to enzyme denaturation and reduced growth.
While insect developmental rates generally increase linearly with temperature, this relationship fails at extreme heat. High temperatures eventually cause vital enzymes to denature and metabolic processes to break down, leading to a sharp decline in growth and

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eventual death. This upper thermal limit creates a bell-shaped curve for development rather than a simple, infinitely increasing linear relationship.

9. (B) Intensity regulates daily activity rhythms, while photoperiod cues seasonal developmental changes.
Light intensity primarily influences immediate behaviors such as flight initiation, foraging, and mating by affecting visual perception and daily activity cycles. Conversely, photoperiod, which is the duration of daylight, serves as a reliable calendar for seasonal changes. It provides the critical cue for long-term physiological shifts, such as the induction of diapause or the timing of migration.

10. (A) I and III
Photoperiod is the most reliable environmental cue for inducing facultative diapause in temperate regions because it changes predictably with the seasons. Similarly, edaphic factors like soil texture and moisture are critical for the survival and success of insects that pupate underground. However, high humidity does not universally benefit all species; some eggs are prone to fungal infection.

11. (A) Passive wind-assisted migration.
Many small or weak-flying insects engage in passive migration by utilizing high-altitude wind currents for long-distance transport. In this mode of dispersal, the insect controls the timing of takeoff and landing but has little influence over its trajectory or speed once airborne. This strategy allows species to colonize distant habitats while minimizing the energy expenditure required for flight.

12. (C) Uniform distribution : $\frac{V}{M} < 1$
In ecological spatial analysis, the variance-to-mean ratio characterizes how individuals are distributed across a landscape. A uniform or regular distribution occurs when individuals are spaced more evenly than by chance, resulting in a variance significantly lower than the mean. This pattern often arises from antagonistic interactions, such as territoriality or intense competition for evenly distributed resources.

13. (D) The aggregated or clumped distribution of insect pests within an agricultural field.
The negative binomial distribution is the most appropriate statistical model for populations that exhibit clumping or aggregation. In agroecosystems, many pests are found in high concentrations around specific host plants or favorable microhabitats while being absent elsewhere. This distribution occurs when the variance is significantly greater than the mean, indicating non-random, localized clusters of individuals.

14. (C) An aggregated or clumped distribution, likely due to localized resource abundance.
A variance-to-mean ratio significantly greater than one indicates that individuals are clustered together rather than spread randomly or uniformly. This aggregation often results from environmental heterogeneity, such as the concentrated presence of host plants, or from social behaviors like mating swarms. It suggests that individuals are responding to specific localized factors that make certain areas more attractive than others.

15. (A) Both A and R are true and R is the correct explanation of A.
Tethered flight experiments provide valuable data on physiological flight capacity but often overestimate actual duration. In natural settings, insects receive various sensory feedbacks, such as visual cues and wind resistance, which help them determine when to land. Without these environmental signals in a laboratory apparatus, insects may continue flying far beyond their typical natural flight times.

16. (D) It results in reduced metabolic energy costs required to colonize new and distant habitats.
Phoresy is a specialized form of commensalism where one organism attaches to another strictly for transport. For small arthropods with limited mobility, this behavior is an evolutionary advantage as it allows them to reach new, potentially resource-rich habitats without expending significant metabolic energy. This "hitchhiking" strategy is essential for colonizing ephemeral or widely dispersed host resources efficiently.

17. (A) Oriental (Indomalayan) and Australasian realms
Wallace's Line is a prominent biogeographical boundary that runs between the islands of Bali and Lombok. It marks the deep-water transition zone where the faunas of the Oriental and Australasian realms meet. This line explains

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why many Asian insect lineages are absent from Australia and vice versa, reflecting the historical separation of continental plates and ancient sea levels.

18. (C) The Nearctic realm exhibits the highest overall insect biodiversity compared to the Neotropical realm.
Biogeographical principles demonstrate that tropical regions, such as the Neotropical realm, possess significantly higher insect biodiversity than temperate regions like the Nearctic. The tropics provide more stable climates, complex plant communities, and specialized niches, fostering greater species richness. Concepts like endemism and continental drift are fundamental to understanding how these distinct global distributions and biodiversity hotspots formed over time.

19. (A) Beta diversity measures species turnover between habitats; alpha measures diversity within a single habitat.
Alpha diversity refers to the species richness and evenness within a local, homogenous habitat or community. In contrast, beta diversity quantifies the variation in species composition between different habitats or along environmental gradients. While alpha diversity provides a snapshot of local variety, beta diversity highlights how species turnover occurs as one moves across a larger, heterogeneous landscape.

20. (A) II and IV
Simpson's dominance index actually measures the probability that two individuals belong to the same species; therefore, higher values indicate low diversity dominated by few species. Furthermore, alpha diversity is a measure of species variety and evenness within a habitat, not merely a count of individuals or population density. Gamma diversity correctly represents the total regional diversity across landscapes.

21. (B) $r_{\{}\max_{\}}$
The intrinsic rate of natural increase, denoted as $r_{\{}\max_{\}}$, represents the maximum potential growth rate of a population when resources are unlimited and environmental resistance is absent. It is a species-specific constant determined by birth and death rates under optimal conditions. This parameter is crucial for modeling exponential growth and understanding the biotic potential of various insect pest species.

22. (C) The growth rate becomes zero.
In the logistic growth model, the term (K minus N) divided by K acts as a braking mechanism as the population size (N) approaches the carrying capacity (K). When N equals K, the term becomes zero, causing the overall population growth rate to stop. This reflects a state of equilibrium where births and deaths are balanced due to resource limitations.

23. (D) r-selected growth temporarily exceeding the environmental carrying capacity.
Aphids often exhibit r-selected life history traits, characterized by rapid reproduction and short generation times. When resources are abundant, their populations grow exponentially, often overshooting the environment's carrying capacity. This overshoot leads to intense competition and resource exhaustion, resulting in a subsequent population crash. This "boom and bust" cycle is common among many small, highly fecund insect pests.

24. (A) Extensive parental care
Species with r-selected life histories prioritize quantity over quality in offspring production. They are characterized by small body sizes, rapid development, and high fecundity, but they typically provide little to no parental care. This strategy allows them to quickly exploit unstable or ephemeral habitats. In contrast, extensive parental care is a hallmark of K-selected species, which produce fewer, more competitive offspring.

25. (A) P-4, Q-1, R-2, S-3
Natality refers to the birth rate or production of new individuals, while the carrying capacity is the maximum sustainable population size. Biotic potential represents the inherent ability of a species to increase under ideal conditions. Environmental resistance encompasses all the biotic and abiotic factors that prevent a population from reaching its full biotic potential by increasing mortality or reducing fecundity.

26. (B) R.N. Chapman
The concept of biotic potential was formally introduced by R.N. Chapman in the nineteen-twenties to describe the inherent power of an organism to reproduce and survive. He viewed population growth as a struggle between this internal potential and external environmental resistance. This foundational idea helped ecologists understand why populations do not

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grow indefinitely and how environmental factors regulate abundance.

27. (A) Biotic potential
Environmental resistance acts as the collective set of limiting factors that prevent a population from realizing its full biotic potential. While biotic potential drives a population to grow exponentially under ideal conditions, resistance factors like predation, disease, and resource scarcity counteract this drive. The balance between these two opposing forces eventually determines the carrying capacity and population stability.

28. (C) Natural ecosystems have higher stability driven by greater species diversity and complex food webs.
Natural ecosystems generally possess greater ecological stability because of their high species diversity and intricate, redundant food webs. If one species fails, others often fill its functional role, buffering the system against collapse. Conversely, modern agroecosystems are often unstable monocultures with low diversity, making them highly susceptible to rapid pest outbreaks and requiring constant human intervention to maintain productivity.

29. (D) Results in rapid progression due to the presence of a soil matrix and biological legacy.
Secondary succession occurs in areas where a previous community was disturbed but the soil remains intact. Unlike primary succession, which starts on barren rock and takes centuries, secondary succession is much faster because the existing soil contains seeds, nutrients, and microorganisms. This biological legacy allows insect communities to recolonize and transition through developmental stages more quickly toward a stable state.

30. (A) I, II, IV, and V
Agro-Ecosystem Analysis is a holistic approach used in Integrated Pest Management to empower farmers. It focuses on field observations of pest-to-natural enemy ratios, plant health, and weather conditions rather than relying on fixed calendar schedules. By analyzing these dynamic factors, farmers can make informed decisions that minimize chemical use and maximize the natural biological control provided by the ecosystem.

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31. (C) Only 10% of energy is transferred from one trophic level to the biomass of the next level.
The ten percent law describes the inefficiency of energy transfer within food chains. Approximately ninety percent of the energy consumed at one trophic level is lost as heat through respiration or remains in undigested waste. Consequently, only about ten percent is actually converted into biomass available for the next consumer level, which limits the total number of possible trophic levels.

32. (B) Pyramid of Numbers
An inverted pyramid of numbers occurs when a few large primary producers support a vast number of smaller herbivores. In a forest, a single large tree can provide food and habitat for thousands of insects. While the pyramid of biomass or energy would still be upright, the count of individuals is much higher at the herbivore level than the producer level.

33. (D) Resource partitioning
Resource partitioning is an evolutionary strategy where competing species divide a limiting resource, such as food or space, to minimize direct competition. This allows multiple species to coexist within the same habitat by specializing on different parts of the resource. Over time, this process can lead to character displacement, where physical traits evolve to better suit the specific partitioned niche.

34. (C) Two species with identical niches cannot coexist indefinitely in the same habitat.
Gause's Law, or the principle of competitive exclusion, states that two species competing for exactly the same limiting resources cannot coexist in a stable environment. The more efficient competitor will eventually outcompete and displace the other. For coexistence to occur, species must evolve differences in their niches through resource partitioning, ensuring they do not rely on identical segments of the environment.

35. (C) The rate at which prey are killed by the predator population.
In the Lotka-Volterra predator-prey equations, the term involving the product of prey and predator densities represents the interaction rate. Specifically, the coefficient "a" denotes the searching efficiency or attack rate of the predator. Therefore, this term quantifies how many prey individuals are removed from the

population per unit of time as a direct result of predation, driving prey mortality.

36. (C) A decelerating rate of prey consumption that eventually plateaus due to predator handling time.
A Type II functional response is characterized by a consumption rate that rises at a decreasing rate until it plateaus. This decelerating curve occurs because the predator is limited by "handling time," which includes the time spent killing, eating, and digesting each prey item. As prey density increases, handling time becomes more significant than searching time, eventually limiting total intake.

37. (D) Type III : Sigmoidal curve influenced by learning or switching behavior.
A Type III functional response exhibits a sigmoidal or S-shaped curve. At low prey densities, the predator's consumption rate is low, often because it lacks a search image or the prey can easily find refuges. As density increases, the predator "learns" to find the prey or switches its focus to them, causing a rapid increase in consumption before eventually plateauing.

38. (A) The change in predator population size through reproduction or aggregation.
The numerical response describes how the total number of predators in a given area changes as prey density increases. This can occur through two mechanisms: reproductive response, where increased food leads to more offspring, or aggregative response, where predators migrate into areas of high prey density. It complements the functional response, which focuses on the intake of individual predators.

39. (B) The theoretical range of resources a species can utilize without biotic constraints.
An insect's fundamental niche represents the full spectrum of environmental conditions and resources it could potentially use in the absence of competitors and predators. It is determined by the species' physiological tolerances and requirements. In reality, biotic interactions restrict the species to a narrower realized niche, which is the actual environment the insect occupies and utilizes in nature.

40. (A) III, I, V, IV, II
Ecological organization is structured hierarchically based on complexity. The sequence begins with the individual organism, followed by a population of the same species. Multiple populations interacting in an area form a community. The community plus its abiotic environment constitutes an ecosystem, and all the Earth's ecosystems together make up the biosphere, the most inclusive level.

41. (A) II, I, IV, III
Primary succession begins on barren substrates where no life previously existed. The process starts with pioneer species like lichens and mosses that break down rock into soil. Herbaceous plants and grasses then establish, followed by shrubs and sun-loving pioneer trees. Eventually, these are replaced by shade-tolerant species that form the stable forest ecosystem known as the climax community.

42. (D) High interspecific competition leading to competitive exclusion or niche divergence.
When two species share a significant portion of their niche, they compete for the same limiting resources. This intense interspecific competition often results in one species outcompeting the other, leading to local extinction through competitive exclusion. Alternatively, the species may undergo niche divergence or resource partitioning, where they evolve to utilize slightly different resources to reduce competition and allow coexistence.

43. (D) One insect inhibiting fungal growth via chemicals while remaining unaffected itself.
Amensalism is an interspecific interaction where one species is harmed or inhibited while the other remains completely unaffected. An example is when an insect produces metabolic byproducts or defensive chemicals that accidentally kill or prevent the growth of nearby fungi or microorganisms without providing any direct benefit or harm to the insect itself. It is a one-sided negative interaction.

44. (C) Host plant resistance where the plant adversely affects the biology of the insect.
Antibiosis is a mechanism of plant resistance where the host plant produces toxic metabolites or physiological barriers that negatively impact the herbivore's life cycle. It can result in reduced fecundity, slower growth, or increased mortality for the feeding insect. This interaction is a critical component of host plant resistance,

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providing a natural defense against pest damage in agricultural systems.

45. (C) A true but R is false.
Commensalism is indeed a relationship where one species benefits without affecting the other, but it is not a rule that such relationships evolve into parasitism. While some parasites may have evolved from commensal ancestors, many commensal relationships are stable evolutionary strategies that do not transition into harmful parasitic ones. The benefit to one party does not inherently imply eventual harm.

46. (D) The number of individuals dying during age interval x.
In a standard cohort life table, the parameter d_x represents the specific number of individuals from the initial cohort that died during a particular age interval. This raw mortality data is essential for calculating further demographic statistics, such as the age-specific mortality rate and the probability of surviving to the next developmental stage, providing insights into population decline.

47. (A) $q_x = \frac{d_x}{l_x}$
The mortality rate, denoted as q_x, is calculated by dividing the number of individuals that died during an age interval by the number of individuals that were alive at the beginning of that interval. This parameter expresses the probability of death for an individual within that specific stage. It is a vital metric for identifying the most vulnerable periods in an insect's life.

48. (A) I, II, and III
Survivorship curves describe how the probability of survival changes with age. Type I shows high survival in early life, Type II shows a constant mortality rate regardless of age, and Type III shows very high mortality among the young. Most insects, like mosquitoes, produce many offspring but experience high early death rates, thus correctly exhibiting a Type III curve, not Type I.

49. (A) To identify the specific mortality factor driving intergenerational population fluctuations.
Key factor analysis is a statistical technique used to determine which specific mortality factor, such as predation or climate, is most responsible for the changes in population size from one generation to the next. By analyzing k-values across different life stages, ecologists can pinpoint the "key factor" that regulates the population and use this information for more effective pest management.

50. (D) $k = \log(N_n) - \log(N_{n+1})$
The k-value for a specific life stage is calculated by taking the difference between the logarithms of the population size at the start and the end of that stage. This logarithmic transformation allows ecologists to sum the k-values of different stages to obtain the total generation mortality. It provides a standardized measure of mortality that can be easily compared across different factors.

51. (A) Counting the number of moths captured per night in a light trap.
Absolute population sampling involves measuring the exact number of individuals per unit of area or volume, such as soil quadrats or suction samples. In contrast, light traps provide relative population estimates because the number captured depends on insect activity, trap efficiency, and environmental conditions rather than just the actual density. They measure "activity-density" rather than true absolute numbers per unit area.

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52. (D) Mark-release-recapture
The Lincoln-Petersen Index is the fundamental formula used in mark-release-recapture studies to estimate total population size. It operates on the principle that the ratio of marked individuals to the total population is equal to the ratio of marked individuals recaptured to the total number captured in a second sample. This technique is particularly useful for mobile insects in various ecosystems.

53. (C) 500
Using the Lincoln Index formula, the total population is estimated by multiplying the number of initially marked individuals (100) by the total number captured in the second sample (100) and then dividing by the number of marked individuals recaptured (20). This calculation results in an estimated population of five hundred. This method assumes that marked individuals redistribute randomly within the entire population.

54. (C) Efficiency varies with weather, time of day, and insect activity levels.
Relative sampling methods do not measure absolute density but rather the number of insects caught per sampling unit, such as a sweep or trap night. These estimates can be misleading because they are highly influenced by factors that affect insect movement and trap attraction. High activity due to warm weather might result in larger catches even if the actual population density remains unchanged.

55. (A) P-3, Q-4, R-1, S-2
Pheromone traps use species-specific chemicals for attraction, while light traps exploit the positive phototaxis of nocturnal insects. Yellow sticky traps attract insects like aphids and whiteflies by mimicking the color of healthy foliage. Pitfall traps are designed to capture ground-dwelling insects as they move across the surface. Each trap type targets a specific behavioral or sensory response of the insect.

56. (A) Empirical models use historical correlations, while mechanistic models simulate biological processes.
Empirical models are built using statistical relationships between historical pest data and environmental variables, essentially looking for patterns. Mechanistic models, however, are based on the actual biological and physiological processes, such as birth, death, and development rates, that drive population changes. While empirical models are often simpler to create, mechanistic models provide a deeper understanding of why populations fluctuate as they do.

57. (D) Daily temperature (degree-days)
Temperature is the most critical abiotic factor influencing insect phenology because insects are cold-blooded and their metabolic rates are temperature-dependent. Degree-days quantify the heat accumulation required for development, making them highly predictive for timing life cycle events like egg hatch or adult emergence. Consequently, temperature data is the most universally included variable in short-term empirical models for pest forecasting.

58. (A) An epidemic or outbreak
A pest outbreak or epidemic is characterized by a rapid, large-scale increase in population density that exceeds typical seasonal fluctuations and causes significant economic or ecological damage. These events are often triggered by favorable weather, an abundance of host plants, or a decline in natural enemy populations. Understanding the causes of such outbreaks is a primary goal of agricultural entomology and pest forecasting.

59. (B) The disproportionate mortality of natural enemy populations compared to the target pest population.
Pesticide-induced resurgence occurs when a pest population bounces back to even higher levels after a chemical application. This happens because broad-spectrum insecticides often kill a greater percentage of the natural enemies than the target pests. Freed from the pressure of predators and parasitoids, the surviving pests reproduce rapidly, leading to a much larger and more damaging population than before the treatment.

60. (B) I and III
Secondary pest outbreaks are frequently caused by the destruction of natural enemies that previously kept minor pests in check. Climate change also exacerbates outbreaks by improving overwintering survival and increasing the number of generations per year. However, monoculture agriculture actually increases the likelihood of outbreaks by providing a uniform food source and reducing the environmental complexity that supports beneficial insects.

61. (A) Reducing biodiversity and isolating populations, which can hinder the natural control of pests.
Habitat fragmentation breaks large, continuous environments into smaller, isolated patches. This process often reduces biodiversity because many species cannot survive in small fragments or travel between them. In agricultural landscapes, fragmentation can isolate natural enemy populations from the pests they control, leading to reduced biological control efficacy and an increased risk of localized pest outbreaks in the remaining crop areas.

62. (C) Crop rotation
Crop rotation is a cultural control method that involves changing the type of crop grown in a field each year. This practice disrupts the spatial and temporal continuity of resources for specialized pests. By planting a non-host crop,

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farmers can cause the localized pest population to starve or fail to reproduce, effectively reducing their abundance in subsequent years without the need for chemicals.

63. (D) Exposure of overwintering pupae to lethal desiccation, heat, and predators.
Deep summer tillage physically disturbs the soil environment where many insects pupate or overwinter. By bringing these life stages to the surface, tillage exposes them to lethal environmental conditions, such as extreme heat and desiccation from the sun. Additionally, it makes the insects more accessible to birds and other surface-dwelling predators, significantly reducing the survival of the next generation.

64. (C) Analysis of interactions between multiple herbivore species, host plants, and natural enemies.
Synecology is the study of groups of organisms that coexist as a unit within an ecosystem. A synecological study of an agricultural field focuses on the complex web of interactions among various pest species, their host plants, and the guild of natural enemies that prey upon them. It seeks to understand community-level processes such as competition, predation, and energy flow within the system.

65. (B) Sampling a population at one specific point in time to determine the age distribution of individuals currently alive.
A time-specific or static life table provides a snapshot of a population's age structure at a single moment. It assumes that the population is stable and that the different age classes sampled represent what happens to a single cohort over time. This method is often more practical than following a single cohort from birth to death, especially for long-lived or overlapping generations.

66. (A) $H' = -\sum(p_i \ln p_i)$
The Shannon-Wiener diversity index is a widely used mathematical tool that accounts for both the number of species and their relative abundance, or evenness. In the formula, "p_i" represents the proportion of individuals belonging to the i-th species. Higher index values indicate greater diversity and a more even distribution of individuals among the different species present in the community.

67. (D) The dominance of the most abundant species Simpson's Diversity Index is more sensitive to changes in the abundance of common species than the Shannon-Wiener index. It specifically measures dominance by calculating the probability that two randomly selected individuals belong to the same species. A higher value for the dominance index indicates that the community is heavily dominated by one or a few very abundant species, reflecting lower overall evenness.

68. (C) It reliably guarantees the complete eradication of all polyphagous insect pests.
While polyculture increases natural enemy diversity and makes host location more difficult for specialists, it cannot guarantee the complete eradication of all pests. Polyphagous insects, which feed on many different plants, may still find suitable hosts within a mixed cropping system. Polyculture is a management strategy designed to reduce pest pressure and enhance stability, not a method for total species elimination.

69. (A) Both A and R are true and R is the correct explanation of A.
The realized niche is the actual range of conditions and resources a species uses in nature, and it is almost always smaller than the fundamental niche. This reduction is caused by biotic limiting factors, particularly competition with other species for the same resources and pressure from predators or pathogens. These interactions prevent the species from exploiting its full physiological potential.

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70. (A) I and III
Dispersal is not always unidirectional; many insects, like migratory butterflies, exhibit return journeys. Furthermore, phoresy is a passive form of dispersal where an insect hitchhikes on another organism, rather than an energy-intensive active flight. Conversely, migration is correctly defined as a specialized, persistent movement, and dispersal indeed helps reduce intraspecific competition and prevents inbreeding by spreading individuals across the landscape.

71. (A) The removal of a strong competitor, allowing a suppressed species to expand its realized niche.
Competitive release occurs when a species is freed from the limiting effects of a dominant competitor, often due to its removal or a decline in its population. This absence allows the

are infinite and that there is no environmental resistance. While no population can grow this way forever, many insects exhibit this pattern during initial colonization or during the early stages of a seasonal outbreak.

108. (C) Failure if conditions drift outside historical data ranges used for calibration.
Empirical models are based on statistical correlations found in past data. Their primary limitation is that they may not be reliable if environmental conditions change in ways not seen in the historical record, such as during extreme weather events or long-term climate shifts. Because they do not model the underlying biological mechanisms, they cannot predict how populations will react to novel conditions.

109. (A) Mesopredator release, potentially leading to over-exploitation of primary consumers.
The removal of apex predators often leads to a phenomenon called mesopredator release, where populations of smaller, mid-level predators increase because they are no longer being suppressed. These mesopredators may then exert excessive pressure on primary consumers, such as herbivorous insects. This disruption of the trophic structure can have cascading effects throughout the ecosystem, potentially reducing overall stability and altering community composition.

110. (B) I and IV
It is incorrect to say that pitfall traps provide an absolute population density, as they measure activity-density rather than true numbers per unit area. Likewise, quadrat sampling is actually well-suited for immobile insects, so labeling that statement as incorrect is wrong. However, the question asks for the incorrect combination, and mark-release-recapture is indeed best for closed populations while sweep netting is highly operator-dependent.

111. (B) Intraspecific competition for limited host plant resources.
Density-dependent mortality occurs when the probability of an individual dying increases as the population becomes denser. Intraspecific competition is the most critical driver of this, as more individuals compete for a finite amount of food or space. As resources become scarce, mortality rises due to starvation or reduced fitness, effectively regulating the population and preventing it from growing indefinitely beyond its carrying capacity.

112. (A) Ratio of energy passed to next trophic level divided by energy from the previous.
Ecological efficiency quantifies how much energy is successfully transferred from one trophic level to the next. It is calculated by dividing the energy available at the higher level by the energy that was available at the level below it. Because of losses due to respiration and waste, this efficiency is typically low, averaging around ten percent across most natural and agricultural ecosystems.

113. (C) The proportion of r-selected, highly dispersive herbivore species.
Agroecosystems, like wheat fields, are frequently disturbed environments that favor r-selected species. These insects are characterized by rapid reproduction, short life cycles, and high dispersal abilities, allowing them to quickly colonize and exploit the abundant but temporary resources provided by the crop. In contrast, mature forests have more stable conditions and a higher proportion of K-selected species with complex competitive strategies.

114. (D) Temporary, direct halt in development due to adverse conditions, reversing immediately.
Quiescence is a physiological state where development or activity stops as a direct and immediate result of unfavorable environmental conditions, such as extreme temperatures. Unlike diapause, it is not genetically programmed and does not require a specific stimulus to break. Growth resumes immediately as soon as the environment becomes favorable again, providing a flexible way for insects to handle short-term stress.

115. (C) Competitive exclusion : Releasing a hyperparasitoid to exclusively protect the primary pest.
Releasing a hyperparasitoid would actually be counterproductive for pest control, as hyperparasitoids attack the beneficial parasitoids that regulate pests. This does not exemplify the principle of competitive exclusion in a useful agricultural sense. The other pairings, such as using degree-days for timing or border crops for habitat management, are correct and widely used applications of ecological principles in integrated pest management.

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uniform patterns where individuals are more evenly spaced than by chance. The negative binomial distribution describes aggregated or clumped patterns where individuals cluster. Lastly, the normal distribution is a continuous, symmetrical bell-shaped curve used for many types of biological and physical data.

81. (B) I and II
Pitfall traps provide a relative measure of activity-density, not an absolute density per unit area, because catch size depends on how much insects move. Similarly, suction traps typically provide a relative estimate of aerial density rather than an absolute count of the entire population. Sweep netting and light traps also yield relative data, though light traps are notably biased toward phototactic species.

82. (D) Deep-water trenches that prevented land bridge formation during Pleistocene glaciations.
Wallace's Line coincides with deep-water channels that separated the continental shelves of Asia and Australia even during periods of low sea levels. These trenches acted as a permanent barrier to the dispersal of land animals and many insects, preventing the formation of land bridges. This geological separation allowed the biotas on either side to evolve independently, creating distinct biogeographical realms.

83. (A) G.F. Gause
G.F. Gause conducted pioneering laboratory experiments with different species of Paramecium to study competition. He observed that when two species competed for the same limited food resource, one eventually outcompeted and eliminated the other. These findings led to the formulation of the competitive exclusion principle, which remains a fundamental concept in ecology for understanding how species coexist or displace each other.

84. (C) Designing statistically robust and cost-effective field scouting and sampling protocols.
Understanding how insects are distributed in a field—whether they are random, uniform, or clumped—is essential for developing effective sampling plans. These protocols ensure that pest density is estimated accurately with minimal effort. For example, aggregated pests require different sampling intensities and patterns than randomly distributed ones to provide a reliable basis for making informed pest management decisions.

85. (A) Both A and R are true and R is the correct explanation of A.
The logistic growth curve starts with an exponential phase because resources are abundant and resistance is low. As the population grows, factors like limited food and increased predation—collectively known as environmental resistance—begin to slow the growth rate. Eventually, these limiting factors balance the population at the carrying capacity, causing the curve to level off and form an asymptote.

86. (C) Life expectancy, or average time units an individual of age x has left to live.
In life table analysis, the parameter e_x represents the life expectancy at age x. It is calculated as the average number of additional time intervals an individual is expected to live, given that it has already survived to its current age. This value is crucial for understanding the aging process and the total reproductive potential remaining for individuals within a population.

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87. (D) Type III
A Type III survivorship curve is characterized by extremely high mortality rates during the earliest stages of life, such as the egg and young larval phases. However, for the few individuals that manage to survive these vulnerable stages, the probability of survival increases significantly, and they tend to live for a relatively long and stable period as adults. Most insects follow this pattern.

88. (A) Ecotone : The transition zone between two distinct ecological communities.
An ecotone is a boundary area where two different ecosystems meet and integrate, such as the transition between a forest and a grassland. These zones often harbor high biodiversity because they contain species from both adjacent communities as well as specialized species unique to the edge environment. This "edge effect" makes ecotones ecologically significant areas for studying species interactions and diversity.

89. (B) A diverse, stable climax community with complex interspecific interactions.
Ecological succession is the process of change in species composition over time. It typically progresses from simple, pioneer communities to

125. (A) A biological event, like first pheromone trap catch, used to start DD accumulation.
A biofix is a critical biological event that serves as the starting point for calculating degree-day accumulation in a given season. It ensures that the heat accumulation is synchronized with the actual presence and activity of the insect in the field. Common biofixes include the first consistent trap catch of adults or the observation of the first eggs, improving the accuracy of forecasting.

126. (B) Large-scale climate variables from preceding seasons, such as rainfall patterns.
Long-term forecasting of insects like grasshoppers often relies on climate patterns from previous seasons. For example, specific rainfall amounts in the preceding year can influence soil moisture and vegetation growth, which in turn affect the survival and egg-laying success of the previous generation. These large-scale environmental indicators provide a statistically significant basis for predicting major population shifts in the coming year.

127. (D) Localized increase in predator density following an influx of migratory species.
A numerical response occurs when the density of a predator population changes in response to the density of its prey. This can happen through reproduction or, as in this case, through aggregation. When predators migrate into an area where prey is abundant, their local numbers increase. This is a key mechanism for the natural regulation of pest populations in agricultural and natural ecosystems.

128. (A) II, III, I
Spatial distribution patterns are characterized by their variance-to-mean ratios. Uniform or regular distributions exhibit the lowest ratio, typically below one, as individuals are spaced evenly due to competition or territoriality. Random distributions follow a Poisson process where the ratio equals one. Aggregated or clumped distributions show the highest ratios, reflecting individuals clustering around localized resources or exhibiting social behaviors.

129. (D) Repelling pests from crops using intercrops and attracting them to trap crops.
The "push-pull" strategy is a sustainable habitat management technique. It involves intercropping a main crop with a species that "pushes" pests away using repellent volatiles. Simultaneously, a different "pull" crop is planted around the field borders to attract the pests away from the main crop. This integrated approach reduces pest damage while enhancing the presence of beneficial natural enemies in the system.

130. (A) Enhanced biotic potential and faster growth rate, assuming males fertilize multiple females.
In many insect species, a single male can fertilize several females. Therefore, a population with a higher proportion of females has a greater capacity for egg production and overall growth. This skewed sex ratio increases the biotic potential of the species, allowing the population to expand more rapidly when environmental conditions are favorable, which is common in many r-selected pest species.

131. (A) III, I, IV, II
Energy flow in an ecosystem always starts with primary producers, such as green plants. It then moves to primary consumers, which are the herbivores that eat the plants. Secondary consumers are predators that feed on the herbivores, and tertiary consumers are top-level predators that eat other carnivores. This sequence represents the classic trophic levels through which energy and nutrients are transferred.

132. (D) Reduced fitness at very low densities due to difficulties in finding mates.
The Allee effect describes a situation where population growth is restricted at very low densities because individuals struggle to find mates or perform social behaviors. Unlike typical density-dependence where growth slows at high densities, the Allee effect causes a decline in per capita fitness when the population is too small. This can lead to local extinction even if resources are otherwise abundant and available.

133. (C) Utilizes a high-powered suction fan to collect insects from the plant canopy into a net.
A D-vac is a specialized vacuum device used for absolute population sampling. It uses a motor-driven fan to suck insects directly from the foliage and into a collection bag. This method is highly effective for sampling a wide range of insects from the crop canopy, providing a more comprehensive and standardized estimate of density compared to manual methods like sweep netting or visual counts.

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applies to species with identical niches, not completely distinct ones. In contrast, it is true that fundamental niches are theoretically determined without competition and that resource partitioning allows sympatric species to reduce competition and coexist.

99. (B) Termites relying on gut protozoa and bacteria to digest cellulose.
Mutualism is a symbiotic relationship where both species benefit. Termites cannot digest the cellulose in wood on their own and rely on specialized microorganisms in their gut to break it down. In return, the termites provide these microbes with a stable environment and a constant supply of food. This obligate relationship is essential for the survival and ecological success of both parties.

100. (D) Seasonal changes in temperature, photoperiod, and host plant availability.
Large-scale migrations, like those of the Monarch butterfly, are driven by predictable seasonal shifts in the environment. As winter approaches, declining temperatures and shorter day lengths signal the need to move to warmer climates. Additionally, the senescence of host plants forces the insects to migrate to areas where food will be available, ensuring the survival of the population until the next breeding season.

101. (B) Severe drought causing widespread wilting and nutritional decline of the host crop.
The carrying capacity is the maximum population size an environment can support based on available resources. A severe drought directly reduces the quality and quantity of food by causing host plants to wilt and lose nutritional value. This sudden resource depletion lowers the carrying capacity, as the environment can no longer sustain as many individuals as it could under favorable, well-watered conditions.

102. (B) The calculation of Pielou's evenness index ($J' = \frac{H'}{\ln S}$).
Species evenness describes how equally the individuals in a community are distributed among the different species present. Pielou's evenness index is a standard metric for this, derived by dividing the observed Shannon diversity by the maximum possible diversity for that number of species. It ranges from zero to one, with higher values representing a more balanced and even community composition.

103. (A) Absolute density measures insects per unit area/volume; relative density uses sampling units.
Absolute density provides a precise estimate of the number of insects per specific unit of the environment, such as individuals per square meter. Relative density, however, expresses population size in terms of sampling effort, like insects per ten sweeps of a net. While absolute density is more accurate for detailed ecological studies, relative density is often faster and easier for routine pest monitoring.

104. (A) P-2, Q-4, R-1, S-3
In a life table, l_x is the proportion of the original cohort surviving to age x, and d_x is the number that died during that interval. The mortality rate, q_x, is the ratio of those who died to those who were alive at the start of the stage. Finally, S_x represents the survival rate, which is the complement of the mortality rate.

105. (A) Both A and R are true and R is the correct explanation of A.
Natural ecosystems are inherently more stable than agricultural monocultures because their high biodiversity creates a resilient network of interactions. Complex food webs provide multiple pathways for energy flow and offer redundant control mechanisms for potential pests. If one natural enemy species declines, others can often compensate, preventing the sudden and massive population explosions that frequently plague simplified, genetically uniform agroecosystems.

106. (C) A continuous, rapid turnover of dominant plant and insect species.
A stable climax community is characterized by its permanence and lack of rapid species turnover. Once established, the dominant plant and insect species remain relatively constant over long periods because they are well-adapted to the environment and each other. High species diversity and complex interactions create a balanced system that resists major changes, unlike earlier successional stages which show rapid species replacement.

107. (B) Exponential population growth in an unlimited environment.
This mathematical equation represents exponential growth, where the population increases at a constant rate relative to its current size. It assumes that resources like food and space

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account for beta diversity (species turnover) and gamma diversity (total landscape richness).

143. (B) 10
Accumulated degree-days are calculated using the daily average temperature minus the base developmental threshold. For this specific scenario, the average of fifteen and twenty-five degrees Celsius is twenty degrees Celsius. Subtracting the base threshold of ten degrees from this average yields a total of ten degree-days. This metric accurately quantifies the thermal energy available for growth and development on that day.

144. (D) Strong antagonistic interactions, such as territoriality, forcing even spacing.
A variance-to-mean ratio significantly less than one indicates a uniform or regular spatial distribution. This pattern suggests that individuals are spaced more evenly than would be expected by chance. Such regularity is often the result of negative biotic interactions, such as territorial behavior or intense competition for resources, which force individuals to maintain a minimum distance from one another across the habitat.

145. (A) The historical fragmentation of the supercontinent Gondwana.
Disjunct distributions, where related species are found in widely separated geographical areas, are often explained by plate tectonics. The presence of a lineage in South America, Africa, and Australia suggests that its ancestors lived on the supercontinent Gondwana before it broke apart millions of years ago. As the continents drifted, the populations were isolated, leading to the distinct modern-day distributions.

146. (B) Species A benefits, Species B is entirely unaffected.
Commensalism is a type of symbiotic interaction where one organism, the commensal, derives a benefit while the other, the host, is neither helped nor harmed. An example in the insect world might include small insects that live within the nests of larger social insects, scavenging on waste or debris without impacting the life or health of the host colony in any significant way.

147. (A) An unpredictable, frequently disturbed, or newly formed ephemeral habitat.
The r-selection strategy is most advantageous in environments that are unstable or temporary. In these settings, the ability to reproduce quickly and disperse widely allows a species to colonize new areas and exploit resources before they disappear. These species prioritize high fecundity and rapid development over individual competitiveness, which is less important when habitats are frequently disturbed or resources are temporarily superabundant.

148. (C) Biotic interactions like interspecific competition, predation, and parasitism.
While a species' fundamental niche is defined by its physiological limits, its realized niche is what it actually occupies in the presence of other organisms. Biotic interactions, such as competition for food or pressure from natural enemies, prevent the species from using all the resources it theoretically could. These constraints force the species into a narrower ecological role, which is its realized niche in nature.

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149. (A) Maximum limits imposed by available food resources and environmental resistance.
The carrying capacity is not a fixed number but a dynamic limit set by the environment. It is determined by the availability of essential resources like food and space, balanced against the pressures of environmental resistance, such as predation and disease. As these factors change, the carrying capacity for a pest species in an agroecosystem will fluctuate, defining the maximum sustainable population size.

150. (A) The net reproductive rate (R_0) and generation time (T).
A life table provides the foundational data on age-specific survival and fecundity. These values allow ecologists to calculate the net reproductive rate, which is the average number of female offspring produced by a female in her lifetime, and the generation time, which is the average time between generations. These parameters are essential for predicting population growth rates and understanding life history strategies.

151. (A) Chain traces single pathways; pyramid illustrates total energy at each trophic level.
A food chain provides a simple, qualitative description of who eats whom in a linear sequence. In contrast, an ecological pyramid of

116. (D) The insect's inherent maximum fecundity ($r_{\{}\max_{\}}$).
Environmental resistance consists of all the external factors that limit population growth, including biotic pressures like predation and disease, as well as abiotic factors like extreme weather. The inherent maximum fecundity of an insect is part of its biotic potential, not environmental resistance. It represents the internal capacity for growth that resistance factors act against to determine the actual population size.

117. (A) Air layer near ground where wind is slower than flight speed, allowing directional control.
The boundary layer is the thin layer of air close to the ground or plant surfaces where wind speed is reduced by friction. Within this layer, an insect's flight speed exceeds the wind speed, allowing it to control its direction and stay near its host plants. Once an insect flies above this layer, it is often caught by stronger winds and carried passively.

118. (A) Both A and R are true and R is the correct explanation of A.
Large-scale monocultures create a massive, uniform resource that is ideal for specialized pest species, allowing their populations to explode. At the same time, these simplified landscapes lack the diverse microhabitats and alternative food sources, like nectar and pollen, that are necessary to maintain healthy and effective populations of natural enemies. This combination of abundant food and reduced biological control leads to severe outbreaks.

119. (B) Simpson's Index of Diversity $(1 - D)$
Simpson's Index of Diversity represents the probability that two individuals randomly selected from a sample belong to different species. It is calculated by subtracting the dominance index, which is the sum of the squared proportions of each species, from one. This value increases as diversity and evenness increase, providing a clear measure of the variety within a particular ecological community.

120. (B) A rapidly growing population experiencing exponential increase.
An age pyramid with a wide base indicates that a very large proportion of the population consists of young individuals, such as eggs and larvae. This structure is characteristic of a rapidly expanding population where the birth rate far exceeds the death rate. Such a population is likely in an exponential growth phase, often seen during the early stages of a seasonal pest outbreak.

121. (A) I, III, and IV
Climate change impacts insect ecology in several ways. Elevated carbon dioxide can reduce plant nitrogen, leading to increased herbivory. Warmer temperatures often allow pests to expand their ranges into new areas and can cause phenological mismatches with their hosts or natural enemies. However, warmer temperatures typically increase the number of generations per year for multivoltine insects, rather than uniformly decreasing them.

122. (A) Temporal resource partitioning
Temporal resource partitioning is a strategy that allows similar species to coexist by using the same resource at different times. By being active in different months or seasons, these beetles avoid direct competition for food and space on the host plant. This separation reduces the intensity of interspecific competition and is a key mechanism for maintaining biodiversity within a shared habitat or ecosystem.

123. (D) Gross Primary Productivity (GPP)
Gross Primary Productivity is the total amount of solar energy that primary producers capture and convert into chemical energy through photosynthesis over a specific period. It represents the total energy input into the ecosystem before any of it is used by the plants for their own respiration. Net Primary Productivity is what remains after respiration and is available for consumers.

124. (A) P-2, Q-1, R-3, S-4
Idiobiont parasitoids stop their host's development immediately upon parasitization, while koinobionts allow the host to continue growing. Solitary parasitoids involve only one individual developing per host, whereas gregarious parasitoids allow multiple larvae to share a single host. These different strategies reflect diverse evolutionary adaptations for exploiting host resources and minimizing competition among offspring within the ecological community.

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remaining species to utilize resources that were previously unavailable to it, effectively expanding its realized niche toward its fundamental niche. This phenomenon demonstrates the powerful role of competition in shaping community structure.

72. (A) Requires only a single sampling event to capture age structure snapshots, saving time.
The primary advantage of a time-specific or static life table is logistical efficiency. Rather than tracking a single group of individuals through their entire lives, which can be time-consuming and difficult, a researcher can sample the entire population at once. This snapshot provides immediate data on the current age structure, which can be used to estimate mortality and survival across different stages.

73. (B) Arrested development and reduced metabolism to survive winter or low temperatures.
Hibernation is a seasonal state of dormancy that allows insects to survive the extreme cold and resource scarcity of winter. During this period, the insect's metabolic rate drops significantly, and growth is arrested. This physiological adaptation is often triggered by changes in photoperiod and temperature, ensuring the insect remains inactive until favorable conditions return in the spring.

74. (A) High temperatures, aridity, and resource scarcity during summer months.
Aestivation is a form of dormancy that occurs during periods of extreme heat and drought, common in tropical or arid environments. It allows insects to survive when host plants are desiccated and water is unavailable. By reducing their metabolic activity and remaining in a protected state, insects can endure the harsh summer months until the return of moisture and food resources.

75. (D) Shutdown of prothoracicotropic hormone (PTTH), preventing subsequent molting cycles.
Diapause initiation is controlled by the endocrine system, which integrates environmental signals like day length. A key mechanism involves the brain stopping the secretion of prothoracicotropic hormone. This shutdown prevents the release of ecdysone, the hormone responsible for molting and development. Without these signals, the insect enters a state of physiological arrest, allowing it to survive periods of predictable environmental stress.

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76. (A) Primary producers (Autotrophs)
The first trophic level of any ecosystem is occupied by primary producers, primarily green plants and algae. These autotrophs capture solar energy and convert it into chemical energy through photosynthesis. This stored energy forms the fundamental base of the food chain, supporting all subsequent trophic levels, including herbivores, carnivores, and decomposers, which rely on producers for their nutritional requirements.

77. (D) Represents the complex, interconnected feeding pathways present in a real ecosystem.
While a food chain illustrates a simple, linear sequence of energy transfer from one organism to another, a food web provides a more realistic representation of ecological interactions. It consists of multiple, overlapping, and interconnected food chains, showing how most organisms feed on more than one type of food and are themselves eaten by various predators. This complexity enhances ecosystem stability and resilience.

78. (A) Percentage of ingested energy absorbed across the gut wall rather than egested as frass.
Assimilation efficiency measures how effectively an insect absorbs energy from the food it consumes. It is the ratio of the energy that passes through the gut wall into the body to the total energy ingested. The remaining unabsorbed energy is expelled as waste. This efficiency varies significantly depending on the quality and digestibility of the food source, such as plant versus animal tissue.

79. (B) A sudden, unseasonal hard frost that kills 90% of exposed larvae.
Density-dependent factors, such as competition, predation, and disease, have an impact that changes with population size. In contrast, density-independent factors, like catastrophic weather events or sudden frosts, affect individuals regardless of how many are present in the population. A frost will kill a certain percentage of the population whether it is sparse or dense, making it an abiotic, density-independent regulator.

80. (A) P-2, Q-3, R-1, S-4
The Poisson distribution models random spatial patterns where the variance equals the mean. The positive binomial distribution is used for

134. (D) Beta diversity
Beta diversity is the specific measure used to quantify the change in species composition between different communities or along an environmental gradient. It highlights species turnover, showing how many species are shared or unique as you move from one habitat to another. This metric is essential for understanding regional biodiversity patterns and how environmental factors shape the distribution of various biological communities.

135. (A) I and IV
The intrinsic rate of increase, r, is actually maximized in unstable, early-successional environments where resources are abundant, not in stable climax communities. Also, r-selected species are characterized by high reproductive output with many tiny offspring, but they do not typically devote energy to individual survival or parental care. In contrast, it is true that emigration subtracts from population size and exponential models assume no limits.

136. (D) Disrupting life cycles of specialized pests by removing host plants in alternate years.
Crop rotation is an effective cultural control because many insect pests are highly specialized on specific host plants and have limited mobility. By changing the crop each season, the pest is suddenly deprived of its food source and breeding site. This disruption breaks the pest's life cycle and prevents the population from building up to damaging levels over multiple growing seasons.

137. (A) An extensive genetic bottleneck that drastically reduces the species' adaptive diversity.
A genetic bottleneck typically reduces a species' ability to adapt and often leads to lower population fitness, making it an unlikely cause for an insect becoming a major pest. In contrast, factors like introduction to new areas without natural enemies, the presence of vast monocultures, or the destruction of predators by pesticides are common and well-documented reasons for rapid pest status acquisition and outbreaks.

138. (B) Coupled oscillations where predator abundance lags slightly behind prey abundance.
The Lotka-Volterra predator-prey model mathematically describes a system where the populations of both species fluctuate in a predictable cycle. As the prey population grows, it provides more food for the predators, whose numbers then begin to increase. Eventually, the predators eat enough prey to cause their population to decline, which is then followed by a decrease in the predator population.

139. (A) Product of the stage-specific survival rates across all developmental stages.
Generation survival represents the total probability that an individual will survive from the beginning of its life until it reaches the adult stage. It is calculated by multiplying the individual survival rates of each successive developmental stage, such as egg, larva, and pupa. This cumulative value is a key demographic parameter for predicting population trends and understanding the impact of stage-specific mortality.

140. (B) Comparing the model's predictions against independent, newly collected field data from different years or geographical locations.
Validation is a crucial step in model development to ensure its reliability and accuracy. The most robust approach is to test the model using data that was not used during its original construction or calibration. By checking the model's performance against independent field observations from different times or places, researchers can confirm its general applicability and its ability to make accurate real-world forecasts.

141. (A) Synecology
Synecology is the branch of ecology that investigates the structure and function of entire biological communities. It focuses on how multiple species interact with one another and with their abiotic environment to form a functional unit. Key areas of study include interspecific competition, predator-prey relationships, and the cycling of energy and nutrients through various trophic levels within the specific community or ecosystem.

142. (D) A false but R is true.
It is false to suggest that alpha diversity is sufficient for understanding continental biodiversity; a continent contains many different habitats, each with its own unique species. Reasonably, alpha diversity only measures diversity within a single, local, and homogenous site. To understand regional or continental diversity, one must also

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more complex and diverse ones. The final, stable stage is the climax community, which remains relatively unchanged unless disturbed. This state is characterized by high biodiversity, intricate food webs, and efficient nutrient cycling, representing a mature and balanced ecosystem.

90. (D) Iteroparity (multiple reproductive cycles over a long life).
The r-selected species are characterized by a strategy of rapid reproduction and high dispersal in unstable environments. They typically exhibit semelparity, where they put all their energy into a single, massive reproductive event before dying. Iteroparity, which involves multiple reproductive cycles over a longer lifespan, is a trait more commonly associated with K-selected species that live in stable, competitive environments.

91. (A) II, IV, I, III
The standard AESA process begins with collecting field observations on pests, natural enemies, and plant health. This data is then discussed and visualized by the group, often using a chart. The analysis of these findings, such as the pest-to-defender ratio, informs the decision-making process. Finally, the chosen pest management strategy is implemented in the field to protect the crop.

92. (A) Hyperparasitism
Hyperparasitism is a specialized ecological interaction where an organism acts as a parasite on another parasite. For example, a secondary parasitoid wasp may lay its eggs inside the larva of a primary parasitoid that is already developing within a host caterpillar. This complex relationship adds an extra trophic level to the food web and can significantly influence the effectiveness of biological control.

93. (D) More individuals of one species developing in a host than the host can support.
Superparasitism occurs when more individuals of the same parasitoid species are deposited in a single host than can successfully develop to maturity. This often leads to intense competition among the larvae for limited host resources. In contrast, multiparasitism involves larvae from two or more different species of parasitoids competing within the same host, which is a form of interspecific competition.

NODIA

94. (A) Competition
Competition is an interaction where two or more individuals or species vie for the same limiting resource, such as food, water, or territory. This process inevitably leads to a reduction in the fitness, growth, or survival of the participants because the resource is insufficient to meet everyone's needs. It is a fundamental force that shapes the structure and diversity of ecological communities.

95. (C) The per capita effect of one species on the population growth of the other species.
In the Lotka-Volterra competition model, the coefficients α and β quantify how much one species reduces the carrying capacity of the other. They represent the competitive strength of individuals of one species relative to individuals of the other. For instance, if α is two, it means one individual of the second species has the same inhibitory effect as two individuals of the first species.

96. (C) They arise because the secondary pest is inherently more susceptible to the applied insecticide than the primary pest.
Secondary pest outbreaks actually occur because these pests are often less susceptible or even resistant to the insecticides used to control the primary pest. When the broad-spectrum chemicals kill the natural enemies that previously kept the secondary pest in check, its population explodes. This results in an insect that was once economically insignificant becoming a major threat to the crop.

97. (B) To maintain a sub-population of susceptible pests to mate with resistant individuals, delaying the evolution of widespread resistance.
In resistance management, a refuge is an area planted with non-resistant crops where pests are not exposed to control measures like Bt toxins. This allows susceptible individuals to survive and interbreed with any rare resistant individuals from the treated areas. By diluting the resistance genes in the population, refuges significantly slow down the evolution of widespread pesticide resistance in the field.

98. (A) I and V
Niche overlap does not always lead to immediate extinction; species can coexist through resource partitioning or if resources are temporarily abundant. Furthermore, Gause's Law specifically

energy is a quantitative representation of the total amount of energy present at each trophic level within an entire ecosystem. Because energy is lost at each step, the pyramid is always widest at the bottom and tapers toward the top.

152. (D) Avoiding chemical intervention to allow natural biocontrol to regulate the population.
A favorable pest-to-defender ratio indicates that natural enemies, such as predators and parasitoids, are sufficiently abundant to control the pest population naturally. In such cases, applying chemical insecticides would be unnecessary and counterproductive, as it would likely kill the beneficial insects. The AESA recommendation would be to hold off on treatment and let natural biological control processes maintain the pest below damaging levels.

153. (A) Higher primary productivity for harvestable yield, but lower biodiversity and stability.
Agroecosystems are managed specifically to maximize the production of a harvestable crop, leading to high primary productivity. However, this focus on a single species usually results in low biodiversity and simplified ecological interactions. Consequently, agroecosystems are less stable and more vulnerable to pest outbreaks compared to natural ecosystems, which have lower harvestable yields but greater internal resilience and species variety.

154. (D) Localized extinction following the introduction of a more efficient niche competitor.
Competitive displacement occurs when one species is completely eliminated from an area by another species that is more efficient at utilizing the same limiting resources. This is a direct outcome of the principle of competitive exclusion. It is often observed when a new, invasive species enters a habitat and outcompetes the native species that occupy the same ecological niche, leading to localized extinction.

155. (A) Introducing a harmless herbivore to outcompete a pest for identical resources.
This strategy uses the principle of competitive exclusion to manage pests without chemicals. By introducing a non-damaging species that occupies the same niche as the pest, ecologists can force the pest out of the environment through intense competition for food or space. This form of biological control relies on the fact that two species cannot share the same niche indefinitely.

156. (D) Consumption lags at low prey densities due to search image lack, followed by a surge.
In a Type III functional response, the predator's rate of prey consumption is initially very low at low prey densities. This often happens because the predator has not yet "learned" to recognize the prey or because the prey can easily find refuges. As prey density increases, the predator becomes more efficient at finding and capturing them, leading to a rapid increase in consumption.

157. (D) A catastrophic late-spring frost.
Density-dependent mortality factors have an impact that increases as the population grows, such as disease or competition. A catastrophic frost, however, is an abiotic, density-independent factor. It kills a certain percentage of the population based on the intensity of the cold and the vulnerability of the insects, regardless of whether there are ten or ten thousand individuals in the area.

158. (D) Simulating the actual biological processes driving the population dynamics.
The primary role of a mechanistic model is to provide a deep, biological understanding of population changes. By simulating fundamental processes such as birth, death, and development as they are influenced by environmental factors, these models can predict how populations will behave under various scenarios. They are more robust than empirical models because they are based on the underlying causes of population fluctuations.

159. (A) I, II, and III
Symbiosis encompasses several types of interactions. Mutualism provides benefits to both species, as seen in the relationship between termites and their gut microbes. Amensalism is a one-sided negative interaction where one species is harmed while the other is unaffected. Obligate endosymbionts like Buchnera are essential for their hosts' survival. However, commensalism does not inevitably lead to competition; it is a stable interaction.

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2010

7. Who among the following is historically credited with first coining the term "Biological Control" in 1919?
(A) C.V. Riley
(B) Paul DeBach
(C) Albert Koebele
(D) Harry S. Smith

2005

8. Identify the INCORRECT pair of historical pioneers and their primary association in the field of biological control:
(A) F. Muir - Pioneered the large-scale inundative release of Trichogramma
(B) C.V. Riley - Directed the introduction of the Vedalia beetle into California
(C) Albert Koebele - Explored Australia for natural enemies of the cottony cushion scale
(D) Paul DeBach - Authored the foundational text "Biological Control of Insect Pests and Weeds"

2003

9. Match List I with List II.
List I: (Historical Milestone)
P. First major classical biocontrol success (1889)
Q. Early success in weed biological control (1925)
R. Pioneering control of the greenhouse whitefly
S. First major international biocontrol organization
List II: (Subject or Location)
1. Encarsia formosa
2. Cottony cushion scale in California
3. IOBC (International Organization for Biological Control)
4. Prickly pear cactus in Australia
(A) P-2, Q-4, R-1, S-3
(B) P-4, Q-2, R-3, S-1
(C) P-2, Q-1, R-4, S-3
(D) P-1, Q-4, R-2, S-3

2018

10. Which of the following appropriately describes the primary reason for the catastrophic outbreak of the cottony cushion scale (Icerya purchasi) in California prior to 1889?
(A) The sudden development of high-level resistance to broad-spectrum insecticides
(B) The accidental introduction of the pest without its co-evolved natural enemies
(C) The deliberate eradication of indigenous predatory ladybird beetles
(D) A rapid mutation in the scale insect that allowed it to bypass citrus plant defenses

2013

11. Which factor most directly contributed to the rapid success of Rodolia cardinalis (Vedalia beetle) in controlling the cottony cushion scale?
(A) Its short generation time compared to its prey and high prey specificity
(B) Its highly polyphagous feeding behavior allowing it to survive on alternate hosts
(C) Its ability to systemically infect the citrus trees with symbiotic fungi
(D) Its capacity for obligate hyperparasitism in absence of the scale

2007

12. Select the correct chronological sequence of these major historical events in biological control:
(A) Coining of the term "Biological Control" → Introduction of Vedalia beetle → Formation of IOBC → Publication of Silent Spring
(B) Introduction of Vedalia beetle → Coining of the term "Biological Control" → Formation of IOBC → Publication of Silent Spring
(C) Introduction of Vedalia beetle → Formation of IOBC → Coining of the term "Biological Control" → Publication of Silent Spring
(D) Coining of the term "Biological Control" → Formation of IOBC → Introduction of Vedalia beetle → Publication of Silent Spring

2009

13. How did the publication of Rachel Carson's "Silent Spring" indirectly advance the field of biological control?
(A) It provided protocols for the first genomic sequencing of Bacillus thuringiensis.
(B) It proved that chemical pesticides were functionally ineffective in all crops.
(C) It established the first international quarantine protocols for insect species.
(D) It highlighted pesticide damage, shifting focus to integrated biological methods.

2025

14. Which statement is INCORRECT regarding the early history of entomophagous agents?
(A) The ancient Chinese utilized predatory weaver ants (Oecophylla smaragdina) for controlling citrus pests.
(B) Aldrovandi in 1602 accurately recorded the exit of Apanteles larvae from a cabbage butterfly caterpillar.
(C) Early biological control efforts relied heavily

NODIA

CHAPTER 05
Biological Control

NODIA

2005

1. Which of the following best differentiates biological control from natural control in agricultural ecosystems?
(A) Biological control requires active human intervention; natural control happens spontaneously.
(B) Natural control relies solely on abiotic environmental stressors like temperature and moisture.
(C) Natural control mechanisms primarily involve the broad application of synthetic chemicals.
(D) Biological control results in the complete and permanent eradication of all target pests.

2012

2. Which of the following outcomes is generally considered an exception to the primary objectives of an Integrated Pest Management (IPM) program?
(A) Maintaining pest populations below the economic injury level
(B) Enhancing the conservation of indigenous natural enemies
(C) Achieving complete eradication of the target pest species
(D) Integrating multiple compatible pest suppression tactics

2005

3. Consider the following statements regarding the conceptual foundation of biological control:
I. It primarily relies on density-independent mortality factors to regulate pest populations.
II. It exploits the natural functional and numerical responses of natural enemies.
III. It aims to establish a self-sustaining predator-prey or parasitoid-host equilibrium.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I, II and III
(D) I and III

2005

4. In the context of population dynamics, which of the following statements correctly describes a numerical response of a natural enemy?
(A) An increase in the number of prey consumed by an individual predator as prey density increases
(B) A change in the foraging velocity of the natural enemy in response to host plant volatiles
(C) A decrease in the developmental time of the pest due to natural enemy presence
(D) An increase in the reproductive rate of the natural enemy as prey density increases

2025

5. When comparing classical biological control to broad-spectrum chemical insecticidal control, which of the following represents a distinct ecological advantage of the former?
(A) Providing a much faster initial knockdown effect on large, outbreaking pest populations.
(B) Ongoing, density-dependent pest regulation without repeated application costs.
(C) Requiring a significantly lower initial financial investment for research and testing.
(D) Exhibiting a much broader range of toxicity across diverse orders of arthropod pests.

2023

6. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Biological control agents are generally less effective at controlling pests in frequently disturbed, short-term annual cropping systems compared to stable perennial systems.
Reason (R): Frequent agricultural disturbances such as deep ploughing and harvesting disrupt the habitat and life cycles of established natural enemies.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

cellular immune response.
(D) The capacity to develop a heavily sclerotized cuticle in the first larval instar

2014

23. When comparing the host range of idiobionts and koinobionts, which ecological pattern generally holds true?
(A) Idiobionts have highly restricted host ranges because they cannot tolerate different host cuticles.
(B) Both groups exhibit extreme polyphagy regardless of the host's physiological state.
(C) Koinobionts are exclusively monophagous, attacking only a single host species worldwide.
(D) Koinobionts have narrower ranges due to complex physiological interactions.

2021

24. Consider the following statements regarding the physiological strategies used by parasitoids to manipulate host biology:
I. Polydnaviruses (PDVs) are injected by some braconids and ichneumonids to suppress host immunity.
II. Teratocytes are specialized cells derived from the parasitoid egg serosa that absorb host nutrients.
III. Venom injected by idiobionts usually serves to stimulate host feeding and mobility.
IV. Koinobionts often manipulate host endocrinology to delay host pupation.
V. Idiobionts rely on PDVs to maintain the host in a prolonged larval stage.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, II, III and V
(C) II, IV and V
(D) I, III and IV

2004

25. Which of the following is typically NOT a characteristic of idiobiont parasitoids?
(A) They attack hosts in concealed microhabitats, such as leafminers or stem borers.
(B) They induce complex alterations in host behavior post-parasitization.
(C) Paralyze their host permanently at the time of oviposition.
(D) Their larvae usually feed as ectoparasitoids.

2003

26. What is a primary applied advantage of using koinobiont parasitoids over idiobionts in an agricultural biological control program?
(A) Koinobionts kill the pest immediately, halting crop damage on the day of release.
(B) Koinobionts attack early instars while completing development later.
(C) Koinobionts do not require nectar or pollen resources for adult survival.
(D) Koinobionts generally have broader host ranges, allowing them to control all pest orders simultaneously.

2012

27. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Some endoparasitoids lay their eggs in anatomical regions of the host, such as ganglia or salivary glands, where hemocytes cannot easily reach them.
Reason (R): Endoparasitoids must actively prevent or evade encapsulation by the host's cellular immune system to survive.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2005

28. In a field trial, a researcher observes a parasitoid ovipositing into a first-instar caterpillar. The caterpillar continues to feed and cheat normally until it reaches the fifth instar, at which point parasitoid larvae emerge and spin cocoons. This parasitoid is best classified as a:
(A) Larval idiobiont
(B) Pupal idiobiont
(C) Larval-larval koinobiont
(D) Egg-larval koinobiont

2015

29. The phenomenon where a single host is attacked more than once by individuals of the same parasitoid species is defined as:
(A) Multiple parasitism
(B) Hyperparasitism
(C) Adelphoparasitism
(D) Superparasitism

2003

30. Match List I with List II.
List I: (Parasitism Interaction)

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on the genetic engineering of parasitoid wasps.
(D) Erasmus Darwin recognized the potential of natural enemies in pest suppression long before modern entomology.

2005

15. Consider the following statements concerning the classification of entomophagous parasitoids:
I. Egg parasitoids complete their entire development within the host egg.
II. Larval-pupal parasitoids oviposit in the host larva but emerge from the host pupa.
III. Adult parasitoids are always strictly ectoparasitic.
IV. Egg-larval parasitoids oviposit in the host egg and emerge from the mature host larva.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I and III
(C) I, III and IV
(D) II and IV

2008

16. Parasitoids that lay multiple eggs into a single host, allowing several progeny to complete development and emerge, are classified as:
(A) Solitary parasitoids
(B) Hyperparasitoids
(C) Autoparasitoids
(D) Gregarious parasitoids

2025

17. Which of the following biological attributes distinctly separates a parasitoid from a true parasite?
(A) A parasitoid kills its host as a normal part of development.
(B) A parasitoid is generally much smaller than its primary host.
(C) A parasitoid does not kill its host during larval development.
(D) A parasitoid requires multiple hosts to complete immature stages.

2024

18. Which statement correctly identifies a fundamental difference in the developmental physiology of idiobiont and koinobiont parasitoids?
(A) Idiobionts allow the host to feed while koinobionts immediately arrest development.
(B) Idiobionts are exclusively endoparasitic while koinobionts are always ectoparasitic.
(C) Koinobionts allow host growth post-attack while idiobionts paralyze the host.
(D) Koinobionts always attack the pupae while idiobionts always attack host eggs.

2017

19. Identify the correct pairing of parasitoid life-history strategy and its typical behavioral characteristic:
(A) Idiobiont - Ectoparasitic development, broad host range, permanent host paralysis
(B) Koinobiont - Exposed hosts, immediate permanent paralysis, broad host range
(C) Idiobiont - Concealed hosts, narrow host range, specialized venoms
(D) Koinobiont - Endoparasitic development, injects venoms that cause permanent developmental arrest

2011

20. In the lifecycle of a typical Hymenopteran parasitoid, which stage is primarily responsible for host location and habitat selection?
(A) First-instar larva
(B) Pupa
(C) Adult male
(D) Adult female

NODIA

2024

21. Match List I with List II.
List I: (Parasitoid Family)
P. Trichogrammatidae
Q. Braconidae (Subfamily Microgastrinae)
R. Chalcididae
S. Mymaridae
List II: (Targeted Host Stage)
1. Primarily egg parasitoids of various insects
2. Primarily egg parasitoids (often aquatic or hidden eggs)
3. Primarily larval or larval-pupal parasitoids
4. Primarily pupal parasitoids of Lepidoptera and Diptera
(A) P-1, Q-3, R-4, S-2
(B) P-2, Q-4, R-3, S-1
(C) P-1, Q-4, R-2, S-3
(D) P-3, Q-1, R-4, S-2

2024

22. What evolutionary adaptation is most crucial for koinobiont endoparasitoids to successfully complete their development?
(A) The ability to inject necrotizing venoms that liquefy the host instantly
(B) The ability to rapidly consume the host's vital organs within 24 hours of oviposition
(C) The ability to evade or suppress the host's

160. (D) Top predator introduction reducing herbivores, allowing primary producers to flourish.

A trophic cascade is an indirect interaction where changes at the top of the food web "ripple" down to the bottom. For example, when top predators are introduced, they reduce the population of herbivores. With fewer herbivores feeding on them, the primary producers are able to grow more abundantly. This phenomenon demonstrates how predators can play a crucial role in maintaining the health and structure of ecosystems.

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P. Superparasitism
Q. Multiple parasitism
R. Hyperparasitism
S. Kleptoparasitism

List II: (Ecological Definition)

1. A parasitoid attacks a host already parasitized by a different species.
2. A parasitoid attacks another parasitoid developing in or on a host.
3. A parasitoid preferentially attacks a host already paralyzed or prepared by another parasitoid.
4. A parasitoid attacks a host previously parasitized by a member of its own species.

(A) P-2, Q-1, R-4, S-3
(B) P-4, Q-1, R-2, S-3
(C) P-4, Q-3, R-1, S-2
(D) P-1, Q-4, R-2, S-3

2014

31. What is the most common outcome of multiple parasitism involving two different solitary endoparasitoid species developing in the same host?
(A) Both parasitoids complete development by partitioning the host resources.
(B) Only one parasitoid survives due to physiological suppression or physical combat.
(C) Both parasitoids die due to the host's amplified immune response.
(D) The host survives and pupates, ejecting the parasitoid eggs.

2014

32. Host discrimination, a critical behavior in many parasitoids, refers specifically to the ability of the adult female to:
(A) Distinguish between a healthy host and a host infected by entomopathogenic fungi
(B) Distinguish between a host species that is suitable for development and one that is not
(C) Distinguish between host plants based on secondary metabolites
(D) Distinguish between an unparasitized host and a host that has already been parasitized

2005

33. Consider the following steps of parasitoid host selection behavior:
I. Host acceptance
II. Host location
III. Host regulation
IV. Habitat location
Which of the following represents the correct ecological sequence?
(A) IV, II, I, III
(B) II, IV, I, III
(C) IV, I, II, III
(D) II, I, IV, III

2006

34. Which of the following statements regarding superparasitism by a solitary endoparasitoid is INCORRECT?
(A) It can result in reduced size or fitness of the surviving progeny.
(B) It may occur when unparasitized hosts are scarce in the environment.
(C) It always indicates a breakdown of the female's sensory ability to discriminate hosts.
(D) It usually results in intense larval competition, often involving physical combat with specialized mandibles.

NODIA

2007

35. The practice of a secondary natural enemy utilizing the host-searching efforts or host-preparation of another natural enemy to secure provisions for its own offspring is specifically termed:
(A) Kleptoparasitism
(B) Multiparasitism
(C) Autoparasitism
(D) Phytophagy

2007

36. Consider the following statements concerning intrinsic competition among parasitoid larvae within a single host:
I. It only occurs during instances of multiple parasitism, never superparasitism.
II. Physical combat using specialized first-instar mandibles is a common mechanism in solitary parasitoids.
III. Physiological suppression, such as oxygen deprivation or anoxia, can determine the victor without physical contact.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2001

37. In classical biological control, hyperparasitoids are considered highly detrimental because they:
(A) Directly consume the target crop plants, causing secondary agricultural damage
(B) Reduce the population and efficacy of

primary parasitoids regulating the pest
(C) Increase the functional response of the primary parasitoid to pest density
(D) Cause premature pupation of the pest, increasing feeding damage

2023

38. A hyperparasitoid that can develop either as a primary parasitoid on an unparasitized herbivore or as a secondary parasitoid on a primary parasitoid, depending on host availability, is classified as:
(A) An obligate hyperparasitoid
(B) A direct hyperparasitoid
(C) A facultative hyperparasitoid
(D) An indirect hyperparasitoid

2015

39. Which biological feature makes the family Ichneumonidae readily distinguishable from the closely related Braconidae in adult specimens?
(A) Ichneumonidae possess a single recurrent vein in the description of forewing, while Braconidae have two.
(B) Ichneumonidae lack a costal cell, which is prominent in Braconidae.
(C) Ichneumonidae exclusively have an elbowed antenna, unlike Braconidae.
(D) Ichneumonidae have two recurrent forewing veins; Braconidae have one or none.

2001

40. Which of the following pairs correctly represents a primary parasitoid and a common hyperparasitoid genus often associated with it?
(A) Primary: Cotesia; Hyperparasitoid: Lysibia
(B) Primary: Trichogramma; Hyperparasitoid: Aphidius
(C) Primary: Encarsia; Hyperparasitoid: Chrysoperla
(D) Primary: Coccinella; Hyperparasitoid: Tetrastichus

2005

41. Which of the following is NOT a mechanism commonly evolved by primary parasitoids to minimize the risk of hyperparasitism?
(A) Developing rapidly to minimize the vulnerable exposure time
(B) Releasing strong aggregation pheromones from cocoons to attract secondaries.
(C) Concealing cocoons in hidden or protected microhabitats
(D) Remaining within the tough exoskeleton of the host (e.g., aphid mummies) for protection

2015

42. Match List I with List II.
List I: (Ecological Interaction)
P. Primary parasitism
Q. Secondary parasitism
R. Tertiary parasitism
S. Autoparasitism
List II: (Description)
1. A parasitoid developing on a secondary parasitoid
2. A parasitoid attacking an herbivorous pest
3. A male parasitoid developing as a hyperparasitoid on conspecific females
4. A parasitoid developing on a primary parasitoid
(A) P-2, Q-4, R-1, S-3
(B) P-4, Q-2, R-1, S-3
(C) P-2, Q-4, R-3, S-1
(D) P-2, Q-1, R-4, S-3

2007

43. Adelphoparasitism (or heteronomous hyperparasitism), where females develop as primary endoparasitoids of whiteflies or scale insects and males develop as hyperparasitoids on conspecific or heterospecific females, is uniquely characteristic of which family?
(A) Aphelinidae
(B) Trichogrammatidae
(C) Braconidae
(D) Tachinidae

2022

44. Members of the family Trichogrammatidae are exclusively known for being:
(A) Larval endoparasitoids of Diptera
(B) Pupal ectoparasitoids of Hymenoptera
(C) Specialized egg parasitoids of various insect orders.
(D) Nymphal parasitoids of Hemiptera

2005

45. Consider the following statements concerning the traits associated with the family Braconidae:
I. It is one of the most species-rich families of parasitoids.
II. All members are exclusively ectoparasitoids of adult insects.
III. Many species spin distinctive silken cocoons on or near the host after emergence.
IV. Important biocontrol genera include Cotesia and Aphidius.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, III and IV

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(C) II, III and IV
(D) I and IV

2018

46. A defining morphological characteristic used to identify the superfamily Chalcidoidea, which contains many crucial biocontrol agents, is:
(A) Long, multi-segmented antennae with dense plumose hairs
(B) Three distinct, closed submarginal cells in the forewing
(C) Geniculate (elbowed) antennae and highly reduced wing venation
(D) The presence of halteres instead of hindwings

2009

47. When comparing the reproductive strategies of parasitoids, pro-ovigenic species differ from synovigenic species in that pro-ovigenic females:
(A) Must feed on host hemolymph to mature their eggs
(B) Emerge as adults with their full lifetime complement of mature eggs
(C) Emerge with immature eggs and mature them slowly over several weeks
(D) Lay eggs exclusively on the outside of the host cuticle

2010

48. Select the correct taxonomic hierarchy for the parasitoid wasp genus Trichogramma:
(A) Order Hymenoptera → Superfamily Chalcidoidea → Family Trichogrammatidae
(B) Order Hymenoptera → Superfamily Ichneumonoidea → Family Trichogrammatidae
(C) Order Diptera → Superfamily Chalcidoidea → Family Trichogrammatidae
(D) Order Hymenoptera → Superfamily Proctotrupoidea → Family Trichogrammatidae

2019

49. Identify the INCORRECT pair regarding the parasitoid family and its common behavioral or ecological trait:
(A) Mymaridae - Generally large wasps that attack the adult stage of large Lepidoptera
(B) Evaniidae - Parasitoids of cockroach egg cases (oothecae)
(C) Platygastridae - Frequently egg-larval parasitoids of Cecidomyiidae (gall midges)
(D) Encyrtidae - Important endoparasitoids of scale insects and mealybugs, often exhibiting polyembryony

2009

50. Members of the family Tachinidae (Order Diptera) are important parasitoids. Which of the following is a characteristic feature of their parasitism strategy?
(A) They possess an elongate ovipositor to reach concealed hosts deep inside wood.
(B) They invariably lay their eggs inside the host egg stage.
(C) They deposit macrotype eggs on hosts or microtype eggs on host plants.
(D) They construct elaborate paper nests where they provision paralyzed hosts for their larvae.

2016

51. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Predatory insects generally require the consumption of multiple prey individuals to complete their development.
Reason (R): Most predators are significantly smaller than their prey and require concentrated nutrients from multiple sources.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

NODIA

2005

52. A predator that has evolved to feed almost exclusively on a single species or a few closely related species within a single genus is termed:
(A) Polyphagous
(B) Oligophagous
(C) Saprophagous
(D) Monophagous

2006

53. Which of the following represents a fundamental biological difference between an entomophagous predator and a parasitoid?
(A) Predators develop inside hosts while parasitoids live free in the environment.
(B) Predators kill prey quickly; parasitoids allow hosts to live and feed.
(C) Only the adult stage of a predator is carnivorous, unlike all parasitoid stages.
(D) Predators are strictly host-specific, whereas parasitoids attack many prey types.

2010

54. Match List I with List II.

List I: (Predatory Insect Group)
P. Syrphidae (Hoverflies)
Q. Coccinellidae (Ladybirds)
R. Odonata (Dragonflies)
S. Mantodea (Praying mantises)
List II: (Dominant Predatory Stage)
1. Both nymphs and adults are highly predatory.
2. Larvae are predatory, but adults feed on pollen/nectar.
3. Both larvae and adults are highly predatory on terrestrial pests.
4. Aquatic naiads are predatory; adults are highly mobile aerial predators.

(A) P-2, Q-3, R-4, S-1
(B) P-3, Q-2, R-1, S-4
(C) P-1, Q-4, R-2, S-3
(D) P-2, Q-1, R-4, S-3

2011

55. From an applied biological control perspective, what is a primary advantage of utilizing highly polyphagous predators in agroecosystems?
(A) They completely eradicate target pest populations within days.
(B) They exhibit a very strong numerical response specifically tied to a single pest outbreak.
(C) They possess highly specialized enzymes that bypass all pest toxic defenses.
(D) They can sustain their populations on alternative prey or plant resources when the primary pest density is low.

2024

56. What is the most significant ecological risk or disadvantage of releasing highly polyphagous exotic predators in a classical biological control program?
(A) They pose a high risk of attacking non-target, beneficial, or endemic species.
(B) They usually fail to establish in the new environment due to strict dietary needs.
(C) They may undergo rapid evolutionary divergence and become phytophagous.
(D) They have exceptionally long generation times that delay any pest suppression.

2019

57. Consider the following traits that generally characterize an effective predator for augmentation biological control:
I. High searching capacity in the crop habitat.
II. Strict monophagy to prevent non-target effects.
III. Ease of mass rearing on factitious prey or artificial diets.
IV. High prey consumption rate per individual.
V. Very low reproductive capacity to prevent overpopulation.

Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, III and IV
(C) II, III and V
(D) I, IV and V

2011

58. Members of the family Coccinellidae (Coleoptera) are arguably the most widely recognized predators in biological control. The majority of species in this family are specialized predators of:
(A) Stem-boring caterpillars
(B) Soft-bodied Hemipterans like aphids and mealybugs.
(C) Soil-dwelling nematodes
(D) Adult grasshoppers

2006

59. Which of the following pairings of a predatory insect family and its common name/behavior is correct?
(A) Reduviidae - Assassin bugs, ambush predators with a raptorial rostrum.
(B) Carabidae - Green lacewings, specialized aphid predators
(C) Chrysopidae - Ground beetles, predominantly nocturnal soil surface predators
(D) Anthocoridae - Hoverflies, visual predators of aerial insects

2008

60. Consider the following statements concerning the family Carabidae (ground beetles):
I. They are predominantly soil-dwelling, nocturnal predators.
II. Both larval and adult stages are typically predatory.
III. They are considered crucial for conservation biological control of weed seeds and soil pests.

Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

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2022

61. Regarding the feeding mechanics of predatory Hemipterans (e.g., Reduviidae, Anthocoridae), which statement is correct?
(A) They possess strong mandibles adapted for chewing whole prey items.
(B) They capture prey using elaborate silken webs spun from abdominal glands.
(C) They swallow their prey whole and utilize specialized gut gizzards for grinding.
(D) They inject enzymes and suck out liquefied contents via extra-oral digestion.

2002

62. Identify the INCORRECT pairing of a predatory insect family and its respective Order:
(A) Chrysopidae - Neuroptera
(B) Geocoridae - Hemiptera
(C) Syrphidae - Hymenoptera
(D) Staphylinidae - Coleoptera

2022

63. Consider the following statements concerning the role of Syrphidae (hoverflies) in biological control:
I. The adult flies are voracious predators of aphids.
II. The legless, maggot-like larvae are obligate predators of soft-bodied insects.
III. Adults play a dual role in agroecosystems as both pollinators and natural enemy reproducers.
IV. They are rarely associated with crops that provide pollen and nectar.
Which of the above statement(s) is/are correct?
(A) I and III
(B) II and III
(C) I, II and IV
(D) II, III and IV

2014

64. In the context of predatory insect biology, the term "aphid lion" is historically applied to the larvae of which family?
(A) Coccinellidae
(B) Syrphidae
(C) Carabidae
(D) Chrysopidae

2016

65. When applying Chrysoperla carnea in an inundative biological control program, practitioners must be aware that:
(A) Released adults may rapidly disperse from the target field before oviposition.
(B) Only the adult stage will feed on the target pest; larvae are phytophagous.
(C) The larvae require host plant pollen to initiate predatory behavior.
(D) They are strictly monophagous and will starve if the primary pest is absent.

2014

66. Consider the following stages in the infection sequence by a Nuclear Polyhedrosis Virus (NPV) in a Lepidopteran larva:
I. Dissolution of polyhedral inclusion bodies in the alkaline midgut
II. Ingestion of viral occlusion bodies by the feeding larva
III. Lysis of host cells and release of new occlusion bodies into the environment
IV. Fusion of virions with midgut epithelial cells and subsequent replication
Which of the following represents the correct chronological sequence?
(A) II, I, IV, III
(B) I, II, IV, III
(C) II, IV, I, III
(D) IV, I, II, III

2011

67. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Bacillus thuringiensis (Bt) must be ingested by the target insect to cause mortality.
Reason (R): The crystalline endotoxins produced by Bt require activation by specific proteases in the highly alkaline environment of the insect midgut.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2012

68. Match List I with List II.
List I: (Entomopathogenic Microorganism)
P. Baculoviruses (NPV)
Q. Entomopathogenic Fungi (Beauveria)
R. Bacillus thuringiensis
S. Entomopathogenic Nematodes
List II: (Field Symptom)
1. Host cadaver becomes mummified and covered in a white mycelial bloom.
2. Host cadaver turns limp, climbs to a high point (tree top disease), and liquefies.

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measure dispersal capability
3. Determining the ratio of females to males, impacting population growth
4. Measuring the survival duration of adults provided with honey/water

(A) P-3, Q-1, R-2, S-4
(B) P-1, Q-3, R-2, S-4
(C) P-3, Q-2, R-1, S-4
(D) P-4, Q-1, R-2, S-3

2016

129. What is a primary cause of rapid genetic degradation or "laboratory adaptation" in insectary populations of biocontrol agents?
(A) Selection for laboratory traits like crowding tolerance over field foraging skills.
(B) Exposure to outdoor variable weather
(C) Deliberate introduction of wild genetic stock every few generations
(D) Feeding the insects exclusively on their natural target pests

2017

130. How does the economic threshold (ET) concept interface with the economics of augmentative biocontrol?
(A) Biocontrol agents should only be released long after the pest has exceeded the EIL.
(B) The ET concept is mathematically incompatible with biological interventions.
(C) Releasing agents just before the economic threshold to prevent crop injury.
(D) Biocontrol agents lower the market value of the crop, thus increasing the ET.

2010

131. Identify the INCORRECT pairing of an economic/QC term and its standard definition in biocontrol:
(A) Shelf life - Viability duration of a biological product under storage conditions.
(B) Fecundity - The physical distance a parasitoid can fly in one hour
(C) Economic Injury Level - The point at which the cost of biocontrol exceeds the value of the crop
(D) Field recovery rate - The percentage of natural enemy establishment in the field

2001

132. In field evaluation methodologies, a "recovery study" specifically involves:
(A) Recovering financial costs from farmers after releasing the biocontrol agents
(B) Plowing the field to recover surviving soil pests
(C) Treating the field with insecticides to recover the dead bodies of pests
(D) Sampling post-release to confirm natural enemy establishment in the field.

NODIA

2018

133. Consider the following experimental methods used to demonstrate the field efficacy of natural enemies:
I. Exclusion cages (fine mesh preventing natural enemy access to pest patches).
II. Addition plots (releasing large numbers of enemies and comparing to controls).
III. Interference methods (applying selective insecticides that kill enemies but not pests).
IV. Sentinel prey placement (exposing lab-reared pests to measure mortality).
V. Laboratory genomic sequencing of the crop plant.

Which of the above statement(s) is/are correct?
(A) I, II, III and IV
(B) II, III, IV and V
(C) I, III, IV and V
(D) I, II, IV and V

2010

134. Select the sampling technique commonly used to provide an "absolute estimate" of pest and natural enemy density in a crop:
(A) Sweep netting across the canopy
(B) Yellow sticky traps in the field
(C) Calibrated vacuum (D-vac) sampling
(D) Pitfall traps on the soil surface

2025

135. When comparing sampling techniques, how do relative estimates differ from absolute estimates?
(A) Relative estimates measure individuals per hectare; absolute measure insects per trap.
(B) Relative estimates are only used for predators, absolute for parasitoids.
(C) Relative estimates require the destruction of the entire crop.
(D) Absolute estimates provide density per area; relative depends on trap efficiency.

2017

136. Which of the following is generally considered an INAPPROPRIATE or severely flawed technique for evaluating true percent parasitism in a field population of larvae?
(A) Comparing total light trap catches of parasitoids to total catches of pests.
(B) Rearing a random sample of collected field

(A) Bacillus and Pseudomonas
(B) Wolbachia and Rickettsia
(C) Xenorhabdus and Photorhabdus
(D) Agrobacterium and Rhizobium

2019

77. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The only free-living stage of entomopathogenic nematodes that exists outside the host in the soil environment is the third-stage Infective Juvenile (IJ).
Reason (R): The IJ stage is developmentally arrested, morphologically adapted for environmental survival, and retains the mutualistic bacteria in its gut.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2009

78. Identify the correct pairing of an entomopathogenic fungus and the common name of the disease it causes in insects:
(A) Nomuraea rileyi - White halo disease
(B) Beauveria bassiana - Milky disease
(C) Metarhizium anisopliae - Green muscardine disease
(D) Lecanicillium lecanii - Yellow muscardine disease

2025

79. Match List I with List II.
List I: (Biological Agent)
P. Steinernema carpocapsae
Q. Heterorhabditis bacteriophora
R. Bacillus sphaericus
S. Metarhizium acridum
List II: (Specific Characteristic)
1. Highly specialized fungal pathogen used against locusts and grasshoppers
2. Nematode known for an "ambush" foraging strategy near the soil surface
3. Nematode known for a "cruiser" foraging strategy deep in the soil
4. Bacterial pathogen highly effective against mosquito larvae in polluted water
(A) P-2, Q-3, R-4, S-1
(B) P-3, Q-2, R-1, S-4
(C) P-4, Q-1, R-2, S-3
(D) P-1, Q-4, R-3, S-2

2019

80. When applying entomopathogenic nematodes (EPNs) to the field, an agricultural practitioner should ensure that:
(A) The application is done in bright sunlight to activate the nematodes.
(B) The nematodes are mixed with high concentrations of chemical nematicides.
(C) The field is tilled deeply immediately after spraying to bury the nematodes.
(D) The soil is adequately moist before, during, and after application to prevent desiccation.

2006

81. In the context of biocontrol ecology, a tritrophic interaction strictly refers to the ecological and chemical linkages between:
(A) The host plant, the herbivorous pest, and the natural enemy
(B) Three different species of competing parasitoids
(C) Three successive life stages of a holometabolous insect
(D) The soil microbiome, the root system, and the foliar pathogens

2008

82. Which statement correctly describes the function of Herbivore-Induced Plant Volatiles (HIPVs) in a tritrophic system?
(A) They are synthesized by the herbivore to repel attacking natural enemies.
(B) They are emitted by the plant upon herbivore feeding to directly poison the herbivore.
(C) They are specific signals that attract natural enemies to the damaged plant.
(D) They are released by the natural enemy to paralyze the host before oviposition.

2006

83. Consider the following plant morphological traits that can impact the searching efficiency or success of natural enemies:
I. High density of glandular trichomes that entrap small parasitoids.
II. Thick cuticular waxes that prevent the adhesion of predatory insect eggs.
III. The presence of extrafloral nectaries that attract and feed parasitoids.
IV. Complex leaf architectures that provide structural refuges for herbivores.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I and III
(C) II, III and IV

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mass-rear year-round.
IV. It should yield natural enemy progeny with high fitness and field searching capacity.
V. It should require complex living plants for its own rearing.
Which of the above statement(s) is/are correct?
(A) I, II and III
(B) II, III and IV
(C) III, IV and V
(D) I, III and V

2008

114. Which of the following factors is NOT a valid scientific reason for subjecting Corcyra cephalonica eggs to UV radiation before offering them to Trichogramma?
(A) To kill the Corcyra embryo so the host egg does not hatch
(B) To arrest host embryonic development, ensuring internal contents remain optimal
(C) To genetically modify the parasitoid offspring for higher field tolerance
(D) To prevent cannibalism of parasitized eggs by emerging Corcyra larvae

2013

115. During the laboratory mass multiplication of Chrysoperla carnea (green lacewing), a major operational challenge in rearing the larval stage is:
(A) Larvae are highly cannibalistic and must be reared in isolated individual cells.
(B) The larvae require fresh vertebrate blood to molt.
(C) The larvae emit toxic fumes that kill the laboratory staff.
(D) The larvae undergo a strict, multi-year diapause period.

2004

116. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Maintaining genetic diversity in laboratory-reared populations of biocontrol agents is critical for field efficacy.
Reason (R): Continuous inbreeding in artificial environments can lead to genetic bottlenecks and reduced host-searching behavior.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

NODIA

2018

117. In the commercial production of entomopathogenic fungi (e.g., Trichoderma or Beauveria), "solid-state fermentation" primarily utilizes:
(A) Deep tanks of aerated liquid nutrient broth
(B) Solid cereal substrates like rice or sorghum with optimized moisture levels.
(C) Live insect hosts entirely
(D) Sterile soil inoculated with pathogen DNA

2010

118. Comparing submerged liquid fermentation to solid-state fermentation for producing entomopathogenic fungi, a key difference is that:
(A) Submerged fermentation is exclusively used for producing obligate viruses.
(B) Solid-state fermentation requires absolutely zero moisture.
(C) Submerged fermentation yields blastospores; solid-state yields aerial conidia.
(D) Solid-state fermentation is much faster but highly prone to bacterial contamination.

2010

119. Consider the following protective additives commonly used in the commercial formulation of biopesticides:
I. UV protectants (e.g., optical brighteners, titanium dioxide)
II. Humectants (to maintain moisture for spore germination)
III. Broad-spectrum fungicides (to kill competing leaf microbes)
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2021

120. Identify the INCORRECT pairing between a biopesticide formulation type and its physical characteristic:
(A) Water Dispersible Granules (WG) - Large, insoluble pellets designed to sink rapidly without water
(B) Wettable Powder (WP) - Dry formulation mixed with water to form a suspension
(C) Emulsifiable Concentrate (EC) - Liquid formulation containing oil and emulsifiers
(D) Ultra-Low Volume (ULV) - Highly concentrated liquid applied in very small volumes

Which of the above statement(s) is/are correct?
(A) I, II, III and IV
(B) I, III, IV and V
(C) II, III, IV and V
(D) I, II, IV and V

2009

92. Why do classical biological control programs historically report higher success rates against pests in stable habitats like orchards or forests compared to annual row crops?
(A) Orchard pests do not possess cuticular defenses.
(B) Forests and orchards completely lack hyperparasitoids.
(C) Stable habitats allow natural enemies to establish without annual disturbances.
(D) Annual crops produce toxic volatiles that repel all exotic natural enemies.

2014

93. Based on ecological theory, which profile of an invasive pest makes it the most promising candidate for classical biological control?
(A) A highly mobile, migratory native pest in short-term annual vegetable crops
(B) A native soil-dwelling pathogen affecting multiple crop families
(C) An exotic pest that has completely lost its ability to reproduce
(D) A sessile or slow-moving exotic pest infesting perennial plant systems.

2021

94. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): During the quarantine phase of classical biocontrol, any hyperparasitoids found in the imported shipments are meticulously identified and destroyed.
Reason (R): Accidental introduction of hyperparasitoids can severely disrupt both the introduced primary parasitoid and native biocontrol agents.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2018

95. An operational strategy that involves releasing natural enemies with the expectation that they will multiply and control the pest over several generations within a single growing season, but not necessarily establish permanently, is classified as:
(A) Classical Biological Control
(B) Inoculative Augmentation
(C) Inundative Augmentation
(D) Conservation Biological Control

2005

96. How does inundative biological control fundamentally differ from inoculative biological control?
(A) Inundative releases rely entirely on the offspring of the released agents to control the pest, akin to a delayed vaccine.
(B) Inundative control strictly uses only microbial pathogens, whereas inoculative uses insects.
(C) Inundative control aims for permanent, multi-year establishment in an ecosystem.
(D) Inundative releases use massive numbers of agents for rapid, immediate pest suppression, akin to a biotic pesticide.

2007

97. When comparing augmentation strategies, which scenario strongly justifies an inundative release over an inoculative release?
(A) The pest is at the economic threshold and requires immediate suppression.
(B) The pest has just begun to colonize the field, and crop harvest is six months away.
(C) The crop is a perennial forest tree, and long-term equilibrium is the goal.
(D) The natural enemy is highly expensive to rear in large numbers.

2005

98. Consider the following conditions that favor the commercial success of inundative biological control:
I. Availability of cost-effective, large-scale mass-rearing technologies.
II. Short crop cycles where classical establishment is impossible.
III. Natural enemies that establish permanent populations over multiple years.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

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(D) I, III and IV

2005

84. In ecological theory concerning tritrophic interactions, "bottom-up" regulation of herbivore populations refers to:
(A) Mortality inflicted by soil-dwelling entomopathogenic nematodes
(B) Limitation of herbivore populations by natural enemy predation or parasitism
(C) The influence of abiotic climatic factors on overwintering survival
(D) Control of pests via plant nutritional quality and secondary defense chemicals.

2011

85. Which of the following is generally considered an exception, or the LEAST relevant factor, when analyzing the direct chemical signaling in a standard tritrophic biocontrol model?
(A) Kairomones emitted by the herbivore frass
(B) The gravitational pull affecting sap flow dynamics
(C) Synomones emitted by the damaged plant
(D) Pheromones used by the plant for intraspecific defense priming

2004

86. In semiochemical terminology, a chemical substance emitted by one species that evokes a behavioral response in a different species, providing an adaptive benefit to both the emitter and the receiver, is called a(n):
(A) Allomone
(B) Kairomone
(C) Synomone
(D) Pheromone

2023

87. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The emission of Herbivore-Induced Plant Volatiles (HIPVs) is considered an evolutionary mutualism between plants and parasitoids.
Reason (R): The plant benefits from reduced herbivory, while the parasitoid benefits from a reliable chemical cue to locate its host.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2017

88. Classical Biological Control is formally defined as the intentional introduction of:
(A) Exotic, self-sustaining natural enemies for the permanent regulation of invasive pests.
(B) Mass-reared indigenous natural enemies to rapidly knock down a native pest
(C) Broad-spectrum chemical biopesticides derived from botanical sources
(D) Genetically modified crop varieties that produce entomopathogenic toxins

2012

89. Select the logical sequential order of operational steps in a classical biological control program:
(A) Foreign exploration → Quarantine screening → Field release → Post-release evaluation
(B) Quarantine screening → Foreign exploration → Post-release evaluation → Field release
(C) Field release → Foreign exploration → Quarantine screening → Post-release evaluation
(D) Foreign exploration → Post-release evaluation → Quarantine screening → Field release

2014

90. Identify the INCORRECT pairing of a quarantine protocol objective and its underlying rationale:
(A) Rearing imported agents through one or more generations - To eliminate any undetected hyperparasitoids or diseases
(B) Immediate mass field release upon arrival - To prevent the genetic bottlenecking of the imported population
(C) Conducting host-specificity testing - To ensure the agent will not attack beneficial or endemic non-target species
(D) Proper taxonomic identification - To confirm the exact identity of the natural enemy and avoid cryptic species mismatches

2015

91. Consider the following principles that guide the selection of an exotic natural enemy for classical biocontrol:
I. High degree of host specificity.
II. Climatic adaptation similar to the targeted release area.
III. High reproductive potential relative to the pest.
IV. Good searching capability at low host densities.
V. A strong tendency to act as a facultative hyperparasitoid to survive low host periods.

NODIA

III. A mass-reared primary natural enemy that sustains its population on the alternative herbivore.
IV. The targeted pest species which is deliberately inoculated onto the banker plant.

Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, II and III
(C) II, III and IV
(D) I, III and IV

2017

107. When designing a conservation biocontrol strategy to extend the lifespan and increase the fecundity of adult Braconid parasitoids, which field intervention is most directly applicable?
(A) Providing accessible floral resources like Alyssum as nectar sources.
(B) Deep plowing the soil to expose overwintering pupae
(C) Applying sub-lethal doses of pyrethroids to trigger a stress response
(D) Removing all surrounding hedgerows to eliminate pest alternate hosts

2019

108. Identify the INCORRECT statement regarding the principles of conservation biological control:
(A) Reducing the frequency and toxicity of chemical pesticide applications is a fundamental prerequisite.
(B) Creating structural complexity in the landscape generally supports higher natural enemy diversity.
(C) It relies exclusively on the importation of exotic species from international quarantine facilities.
(D) Strip harvesting (e.g., in alfalfa) preserves a reservoir of natural enemies within the field.

2022

109. What is the primary ecological mechanism by which the provision of floral resources (nectar/pollen) in field margins reduces pest populations?
(A) The flowers emit toxins that waft over the crop and kill larval pests.
(B) The flowers physically trap the adult pests as they migrate into the field.
(C) The floral resources promote the rapid growth of entomopathogenic fungi.
(D) Floral resources increase the longevity and reproductive success of natural enemies.

2015

110. In the commercial mass rearing of natural enemies in India, the rice moth, Corcyra cephalonica, is primarily utilized as a:
(A) Biocontrol agent against stored grain pests
(B) Sentinel species to monitor pesticide resistance
(C) Factitious host for rearing parasitoids and predators
(D) Source of commercial insect protein for poultry

2025

111. Match List I with List II.

List I: (Host or Diet)
P. Corcyra cephalonica eggs
Q. Mealybug-infested pumpkins
R. Galleria mellonella larvae
S. Artificial semi-synthetic larval diet

List II: (Natural Enemy)
1. Cryptolaemus montrouzieri
2. Entomopathogenic nematodes (in vivo production)
3. Trichogramma species
4. Chrysoperla carnea (rearing adult stages)

(A) P-3, Q-1, R-2, S-4
(B) P-1, Q-3, R-2, S-4
(C) P-3, Q-2, R-1, S-4
(D) P-2, Q-1, R-4, S-3

2002

112. Consider the following procedural steps for the mass production of Trichogramma chilonis using Corcyra cephalonica:
I. UV irradiation of host eggs
II. Collection of freshly laid Corcyra eggs
III. Gluing eggs onto tricho-cards
IV. Exposure of cards to adult Trichogramma in breeding jars

Which of the following represents the correct sequence?
(A) II, I, III, IV
(B) II, III, I, IV
(C) I, II, III, IV
(D) III, II, I, IV

2019

113. Consider the following attributes that define an ideal "factitious host" for mass multiplication of natural enemies:
I. It must be phylogenetically identical to the target pest.
II. It should be highly susceptible to the natural enemy under laboratory conditions.
III. It must be inexpensive and relatively easy to

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3. Host ceases feeding rapidly, body remains relatively intact initially.
4. Host cadaver turns red, brick-red, or ochre and becomes flaccid but intact.

(A) P-2, Q-1, R-4, S-3
(B) P-2, Q-1, R-3, S-4
(C) P-1, Q-2, R-3, S-4
(D) P-3, Q-4, R-1, S-2

2016

69. Consider the following statements concerning Baculoviruses (e.g., NPV and GV):

I. They are double-stranded DNA viruses.
II. They pose significant health risks to humans and livestock upon exposure.
III. They are highly specific, often infecting only a single or a few closely related host species.
IV. They possess occlusion bodies that protect the virions from environmental degradation.
V. They typically enter the host through the spiracles during respiration.

Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, III and IV
(C) II, III and V
(D) I, IV and V

2014

70. A primary structural difference between Nucleopolyhedroviruses (NPV) and Granuloviruses (GV) is that:
(A) NPVs contain RNA, while GVs contain DNA.
(B) NPVs solely infect the gut epithelium, whereas GVs infect the hemolymph directly.
(C) NPV occlusion bodies contain multiple virions; GVs typically contain only one.
(D) NPVs infect Coleoptera, whereas GVs exclusively infect Lepidoptera.

2024

71. Bacillus thuringiensis var. kurstaki is primarily effective and commercialized for the control of larvae belonging to which insect order?
(A) Coleoptera
(B) Diptera
(C) Hemiptera
(D) Lepidoptera

2013

72. Which of the following is NOT typically observed as a symptom or outcome of insect infection by entomopathogenic bacteria like Bacillus popilliae (milky disease)?
(A) The infected grub continues to feed voraciously until the moment of pupation.
(B) The hemolymph becomes turbid and milky in appearance due to spore proliferation.
(C) The infection primarily targets scarab beetle larvae in the soil environment.
(D) Death occurs over a prolonged period compared to fast-acting Bt toxins.

2023

73. When comparing the mode of entry into the insect host, how do entomopathogenic fungi fundamentally differ from entomopathogenic bacteria and viruses?
(A) Fungi must be ingested to initiate infection, whereas bacteria penetrate the cuticle.
(B) Fungi penetrate the cuticle via enzymes; bacteria and viruses require ingestion.
(C) Fungi exclusively enter through the spiracles, while viruses enter through the cuticle.
(D) Fungi require wounds on the insect body for entry, unlike bacteria which penetrate intact cuticles.

2019

74. The efficacy of field applications of entomopathogenic fungi (e.g., Beauveria bassiana) is often highly variable. This variability is most strongly driven by their critical environmental requirement for:
(A) High ambient ultraviolet (UV) radiation
(B) High ambient relative humidity for conidial germination
(C) Extreme temperatures exceeding 35°C
(D) Dry, windy conditions to facilitate spore penetration

2025

75. Consider the following steps involved in the mode of action of entomopathogenic fungi:

I. Adhesion of conidia to the host epicuticle.
II. Formation of an appressorium and penetration peg.
III. Intracellular replication strictly within the host gut lumen.

Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2003

76. Entomopathogenic nematodes (EPNs) in the families Steinernematidae and Heterorhabditidae rely on a mutualistic symbiosis to kill their insect hosts. The bacterial genera involved are:

NODIA

2017

121. Concerning the mass production of Baculoviruses (e.g., HaNPV), which statement reflects current commercial reality?
(A) They are synthesized entirely in vitro using chemical precursors.
(B) They are predominantly produced in vivo by infecting large numbers of live hosts.
(C) They are produced via solid-state fermentation on boiled rice.
(D) They are extracted from infected plant tissues using solvents.

2010

122. To maximize the shelf life of a formulated bio-insecticide containing conidia of Metarhizium anisopliae, the product should be stored under conditions of:
(A) High temperature and high humidity
(B) Low temperature (refrigeration) and low humidity
(C) Ambient temperature and constant direct sunlight
(D) Freezing temperatures with alternating freeze-thaw cycles

2021

123. Adjuvants such as surfactants (wetting agents) are often added to spray tanks containing entomopathogenic nematodes or fungi primarily to:
(A) Ensure uniform dispersion across waxy plant surfaces to improve contact.
(B) Induce mutations in the pathogen for faster kill
(C) Serve as a primary food source for the pest insect
(D) Neutralize the pH of the soil profile

2009

124. In the commercial quality control (QC) of Trichogramma wasps, which parameter is considered an essential metric of field performance?
(A) The physical weight of the individual adult male
(B) The color intensity of the parasitized egg
(C) The percentage of emergence and proportion of females in the population.
(D) The amount of venom injected into the Corcyra egg

2011

125. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Routine evaluation of flight capacity is an important quality control test for mass-reared parasitoids.
Reason (R): Parasitoids must be capable of active flight to disperse and locate widely distributed pest populations.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2005

126. Consider the following variables that influence the calculated cost-benefit ratio of a commercial augmentative biocontrol program:
I. The cost of mass-rearing facility labor and host diets.
II. The market value of the protected crop yield.
III. The reduction in expenses from displaced chemical pesticide applications.
IV. The global stock price of broad-spectrum chemical companies.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, II and III
(C) II, III and IV
(D) I, III and IV

NODIA

2002

127. Which of the following metrics is NOT typically included in a standardized Quality Control (QC) manual for assessing mass-reared predatory insects?
(A) Adult fecundity (eggs per female)
(B) Genetic sequence of the insect's mitochondrial DNA per batch
(C) Survivorship during simulated shipment conditions
(D) Rates of hyperparasitism in the laboratory colony

2006

128. Match List I with List II.
List I: (QC Parameter)
P. Sex ratio evaluation
Q. Fecundity test
R. Flight propensity test
S. Longevity test
List II: (Method or Consequence)
1. Counting the number of eggs laid per female over a specified time
2. Using flight cylinders with sticky traps to

2001

99. Match List I with List II.
List I: (Augmentation Strategy)
P. Inundative release of Trichogramma
Q. Inoculative release of Phytoseiulus persimilis
R. Application of Beauveria bassiana
S. Release of sterile male insects (SIT)
List II: (Field Scenario)
1. Early season greenhouse introduction to establish a predator population
2. Regular, massive field releases to destroy lepidopteran egg masses
3. Spraying massive doses of conidia for immediate knockdown of an outbreak
4. Flooding the field with non-reproductive males to crash the breeding population
(A) P-2, Q-1, R-3, S-4
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-1, R-2, S-4
(D) P-2, Q-3, R-1, S-4

2018

100. The egg parasitoid Trichogramma chilonis is predominantly utilized in Indian agriculture for which specific biological control strategy against sugarcane borers?
(A) Classical introduction
(B) Conservation ecology
(C) Banker plant engineering
(D) Inundative augmentation

2013

101. Which of the following represents a significant constraint or limitation specific to inundative biological control?
(A) It permanently alters the local ecological food web.
(B) It requires a continuous and economically viable mass-rearing infrastructure.
(C) It requires no knowledge of the pest's life cycle.
(D) It only works on exotic invasive species.

2010

102. Which statement correctly evaluates the relationship between pest voltinism (number of generations) and the choice of augmentation method?
(A) Univoltine pests are best controlled by releasing hyperparasitoids.
(B) Pests with overlapping generations can never be controlled by biological means.
(C) Inoculative releases work well for pests with overlapping greenhouse generations.
(D) Inundative methods are mathematically ineffective against multivoltine species.

2006

103. Conservation biological control relies heavily on "ecological engineering." Which of the following best defines this approach?
(A) The genetic modification of natural enemies to tolerate synthetic pesticides
(B) The mass rearing and timed release of millions of parasitoids using advanced bioreactors
(C) The importation of diverse natural enemies from the pest's region of origin
(D) Manipulating habitats to enhance the survival and success of resident natural enemies.

2001

104. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The establishment of "beetle banks" (raised earth ridges sown with native grasses) in arable fields enhances pest control.
Reason (R): Beetle banks provide undisturbed overwintering refuge habitats for predatory beetles within large crop monocultures.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2012

105. In the context of habitat management, the "Push-Pull" strategy developed for stem borer management in Africa uniquely utilizes:
(A) Synthetic pesticides to push pests out and biological agents to pull them in
(B) Repellent intercrops and attractive trap crops used together.
(C) Light traps to pull pests in, and sound waves to push them out
(D) Parasitoids to push pests off the leaves and predators to pull them into the soil

2007

106. Consider the following components that define a functional "banker plant" system in greenhouse biocontrol:
I. A non-crop plant species grown within or near the primary crop.
II. An alternative, non-pest herbivore species that feeds exclusively on the non-crop plant.

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larvae in the lab until emergence
(C) Dissecting a random sample of field larvae under a microscope
(D) Utilizing molecular markers (e.g., species-specific PCR) on collected host larvae

2004

137. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The use of exclusion cages (sleeve cages) on branches often results in significantly higher pest populations inside the cage compared to uncaged branches.
Reason (R): The fine mesh physically excludes naturally occurring predators and parasitoids from regulating the caged pest population.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2006

138. A researcher collects 100 pest pupae from a sugarcane field. After two weeks in the laboratory, 60 pupae emerge as adult pests, 30 pupae yield Trichogramma adults, and 10 pupae die from unknown causes. Assuming the 10 dead pupae were unparasitized, the apparent percent parasitism is:
(A) 30%
(B) 33.3%
(C) 40%
(D) 60%

2005

139. The international body IOBC, a global advocate and coordinator for biological control research, stands for:
(A) International Organization for Biological Control
(B) Indian Organization for Botanical Control
(C) Institute of Organophosphate and Biopesticide Chemistry
(D) International Order of Biological Conservation

2005

140. Identify the correct pairing of the Indian agricultural organization and its specific mandate regarding biological control:
(A) NBAIR - Regulation of synthetic chemical fertilizer imports
(B) ICAR - Sole commercial manufacturing and sales of biopesticides
(C) CIBRC - Registration and regulation of biopesticides in Indian agriculture.
(D) NBAIR - Rearing of transgenic parasitoids

NODIA

2011

141. Consider the following historical facts concerning CABI (Centre for Agriculture and Bioscience International):
I. It has historically played a massive role in global exploration and classical biocontrol introductions.
II. It operates global open-access databases (e.g., Crop Protection Compendium).
III. It strictly operates only within the North American continent.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2023

142. Match List I with List II.
List I: (Organization)
P. NBAIR
Q. IOBC
R. CABI
S. CIBRC
List II: (Role or Location)
1. Global non-profit organization promoting environmentally safe pest control
2. Nodal agency in India for research on insect resources (Bengaluru)
3. Indian regulatory body overseeing the registration of biopesticides
4. International organization heavily involved in classical weed biocontrol
(A) P-2, Q-1, R-4, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-4, R-1, S-2
(D) P-2, Q-3, R-1, S-4

2007

143. The National Bureau of Agricultural Insect Resources (NBAIR), formerly known as PDBC, which coordinates the All India Coordinated Research Project (AICRP) on Biological Control, is headquartered in:
(A) New Delhi
(B) Bengaluru
(C) Hyderabad
(D) Pune

2010

144. Which of the following statements INCORRECTLY represents the legal or operational mandate of a national biocontrol organization like NBAIR?
(A) Maintaining national repositories of biocontrol agents and host insects
(B) Supplying starter cultures of natural enemies to state agricultural universities
(C) Conducting foundational biosystematic research on indigenous natural enemies
(D) Bypassing all international quarantine laws to fast-track exotic agent importation

2021

145. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Classical biological control inherently requires international cooperation and legal frameworks.
Reason (R): Natural enemies must be explored in the native range of the invasive pest, exported, quarantined, and safely introduced.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2018

146. The highly successful and famous global classical biological control of the invasive weed Opuntia stricta (prickly pear cactus) in Australia was achieved using:
(A) The beetle Chrysolina quadrigemina
(B) The weevil Cyrtobagous salviniae
(C) The moth Cactoblastis cactorum
(D) The rust fungus Puccinia chondrillina

2016

147. Consider the following factors that led to the historic success of the Vedalia beetle (Rodolia cardinalis) against the cottony cushion scale:
I. Excellent climatic matching between its native Australia and introduced California.
II. High specific predation rate on all life stages of the scale.
III. High dispersive capacity of the adult beetles.
IV. Complete dependence on a specific obligate hyperparasitoid for reproduction.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, II and III
(C) II, III and IV
(D) I, III and IV

2013

148. Identify the INCORRECT pairing of a target pest and the globally renowned classical biocontrol agent used to suppress it:
(A) Salvinia weed (Salvinia molesta) - Cyrtobagous salviniae
(B) Cassava mealybug (Phenacoccus manihoti) - Apoanagyrus lopezi
(C) Klamath weed (Hypericum perforatum) - Chrysolina quadrigemina
(D) Gypsy moth (Lymantria dispar) - Cactoblastis cactorum

2023

149. The dramatic success of the moth Cactoblastis cactorum in Australia is primarily attributed to its larval behavior. What specific damage does the larva cause that is so lethal to the prickly pear cactus?
(A) It feeds exclusively on the pollen, preventing seed formation.
(B) Larvae hollow out pads, allowing secondary rot to collapse the plant.
(C) It mines the roots deeply underground, starving the plant of water.
(D) It vectors a lethal viral mosaic disease that stops photosynthesis.

2014

150. Which of the following is a classic example of successful biological control of an INSECT pest (as opposed to a weed) in the historical global context?
(A) Control of Parthenium hysterophorus using Zygogramma bicolorata
(B) Control of water hyacinth using Neochetina weevils
(C) Winter moth control in Canada using specialized parasitoids.
(D) Control of skeleton weed using rust fungi

2001

151. What primary ecological lesson was learned from the massive success of the cassava mealybug control program in Africa using Apoanagyrus lopezi?
(A) Augmentative releases of wasps every month are required in tropical systems.
(B) Natural enemies from South America universally fail to adapt to African climates.
(C) Hyperparasitoids are essential for balancing the food web in root crop systems.

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(D) Successful classical biocontrol can operate on a continental scale in Africa.

2007

152. Which statement accurately describes the biocontrol of the aquatic fern Salvinia molesta by the weevil Cyrtobagous salviniae?
(A) Larvae hollow out the rhizomes, destroying buoyancy and plant growth.
(B) It failed because the weevils drowned in the aquatic environment.
(C) It required the annual inundative release of laboratory-reared weevils.
(D) It was successful only after the weevil was genetically modified for freshwater.

2021

153. In India, the predatory ladybird beetle Cryptolaemus montrouzieri is mass-multiplied and famously utilized for the effective biological control of:
(A) Rice stem borers
(B) Mealybugs infesting diverse crops like citrus, grapes, and coffee.
(C) Coconut rhinoceros beetles
(D) Cotton bollworms

2006

154. Match List I with List II.
List I: (Biocontrol Agent)
P. Epiricania melanoleuca
Q. Zygogramma bicolorata
R. Trichogramma japonicum
S. Cephalonomia stephanoderis
List II: (Target Crop and Pest)
1. Parthenium weed in various habitats
2. Coffee berry borer in coffee plantations
3. Yellow stem borer in rice fields
4. Pyrilla perpusilla in sugarcane
(A) P-4, Q-1, R-3, S-2
(B) P-1, Q-4, R-2, S-3
(C) P-4, Q-3, R-1, S-2
(D) P-3, Q-1, R-4, S-2

2016

155. Consider the following biological control practices standardized for sugarcane pest management in India:
I. Inundative release of Trichogramma chilonis against early shoot borers.
II. Conservation and redistribution of Epiricania melanoleuca for pyrilla control.
III. Application of Metarhizium anisopliae against sugarcane white grubs.
IV. Release of Cactoblastis cactorum to control sugarcane rust.
V. Elimination of all parasitoids to allow ladybirds to flourish.
Which of the above statement(s) is/are correct?
(A) I, II and III
(B) I, III and V
(C) II, III and IV
(D) I, IV and V

2022

156. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The introduction of the parasitoid Aphelinus mali into apple orchards in northern India is considered a historic classical biocontrol success.
Reason (R): Aphelinus mali successfully established and provided permanent suppression of the woolly apple aphid (Eriosoma lanigerum).
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

NODIA

2012

157. Identify the correct pairing of the indigenous biocontrol agent and the severe pest of coconut it is mass-released to control in southern India:
(A) Neochetina bruchi - Red palm weevil
(B) Dipha aphidivora - Coconut eriophyid mite
(C) Aceria guerreronis - Coconut coreid bug
(D) Goniozus nephantidis for the coconut black-headed caterpillar.

2009

158. Which of the following is generally considered an EXCEPTION to the list of spectacular biological control successes in Indian agriculture?
(A) Control of spiraling whitefly using Encarsia guadeloupae
(B) Control of papaya mealybug using Acerophagus papayae
(C) Complete eradication of desert locusts using imported avian predators.
(D) Control of water hyacinth using Neochetina weevils

2007

159. When deploying Trichogramma chilonis via tricho-cards in a cotton field for bollworm management, what is a critical field application guideline?

27. (A) Both A and R are true and R is the correct explanation of A.
Some endoparasitoids strategically oviposit in specific host tissues, such as the nervous system or glands, where they are protected from circulating immune cells. This behavior is an adaptation to evade encapsulation by the host's hemocytes, which is a primary cellular defense mechanism. By avoiding direct contact with the immune system, the parasitoid increases its chances of surviving.

28. (C) Larval-larval koinobiont
A parasitoid that oviposits into a young larva and allows the host to continue feeding and molting until a much later stage is classified as a koinobiont. Specifically, if it both enters and eventually kills the host during the larval stages, it is termed a larval-larval koinobiont. This strategy demonstrates the ability to synchronize development with host physiological processes.

29. (D) Superparasitism
Superparasitism occurs when a single host individual is attacked multiple times by the same species of parasitoid. This behavior can involve the same female or different females of the same species laying eggs in a host that is already parasitized. It often leads to intense competition among the developing larvae, as the host resources are typically limited.

30. (B) P-4, Q-1, R-2, S-3
Intricate ecological interactions define parasitoid behavior, such as superparasitism, where a host is repeatedly attacked by the same species. Multiple parasitism involves different species utilizing the same host individual. Hyperparasitism describes a situation where a parasitoid targets another parasitoid, while kleptoparasitism occurs when one species steals a host already prepared or paralyzed by another species.

31. (B) Only one parasitoid survives due to physiological suppression or physical combat.
In cases of multiple parasitism involving solitary endoparasitoids, typically only one individual survives to complete development. The competitors engage in physical combat using specialized mandibles or utilize physiological suppression, such as oxygen deprivation, to eliminate their rivals. This intrinsic competition ensures that the limited resources of the single host are dedicated to the survival of the strongest individual.

32. (D) Distinguish between an unparasitized host and a host that has already been parasitized
Host discrimination is the critical ability of an adult female parasitoid to distinguish between an unparasitized host and one that has already been attacked. This behavior allows the female to avoid superparasitism, thereby maximizing the survival probability and fitness of her offspring. It is often mediated by chemical markers, or pheromones, left on the host by previous females.

33. (A) IV, II, I, III
The process of host selection by a parasitoid follows a specific ecological sequence starting with habitat location, followed by host location within that habitat. Once a potential host is found, the female must evaluate it for host acceptance before finally engaging in host regulation to ensure a suitable internal environment for her progeny. Each step is guided by varied cues.

34. (C) It always indicates a breakdown of the female's sensory ability to discriminate hosts.
Superparasitism is not necessarily a breakdown of a female's sensory abilities but can be an adaptive strategy when unparasitized hosts are scarce. While it often leads to intense larval competition and reduced fitness of the survivors, it may be the only available option for a female to pass on her genes. Understanding these conditions is vital for predicting efficiency.

35. (A) Kleptoparasitism
Kleptoparasitism is a specialized behavior where a natural enemy utilizes the host-searching or preparation efforts of another species to secure resources for its own offspring. This often involves taking over a host that has already been paralyzed or relocated by a different natural enemy. This interaction highlights the complex and often competitive nature of the relationships between different natural enemies.

36. (B) II and III
Intrinsic competition among parasitoid larvae can occur through various mechanisms, including physical combat using specialized mandibles in the first instar. Alternatively, some species utilize physiological suppression, such as oxygen deprivation, to defeat their competitors without direct contact. These competitive behaviors are

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ANSWERS

1. (A) Biological control requires active human intervention; natural control happens spontaneously.
Biological control is characterized by purposeful human intervention to manipulate populations of natural enemies for pest suppression. In contrast, natural control occurs spontaneously in the environment without human assistance, driven by existing biotic and abiotic factors. This distinction highlights the active management required to establish, augment, or conserve beneficial organisms within specific agricultural, forestry, or aquatic ecosystems.

2. (C) Achieving complete eradication of the target pest species
Integrated Pest Management programs prioritize maintaining pest populations below levels that cause economic damage rather than seeking their total elimination. Complete eradication is generally considered impractical and ecologically unsustainable in most agricultural contexts. Instead, the focus is on utilizing a combination of compatible tactics to achieve long-term, stable pest suppression while minimizing negative environmental and health impacts.

3. (B) II and III
Biological control fundamentally relies on density-dependent mortality factors where natural enemies adjust their impact based on the abundance of the host population. It exploits the inherent functional and numerical responses of predators and parasitoids to achieve a stable equilibrium. This approach aims for a self-sustaining relationship that keeps pest levels below economic thresholds through natural regulatory mechanisms.

4. (D) An increase in the reproductive rate of the natural enemy as prey density increases
A numerical response refers to the change in the population density of a natural enemy as the density of its prey or host fluctuates. This typically involves an increase in the reproductive rate or the recruitment of more individuals to a specific area with high prey abundance. It is a critical component of the overall regulatory capacity of predators.

5. (B) Ongoing, density-dependent pest regulation without repeated application costs.
Classical biological control offers a distinct ecological advantage by providing ongoing, density-dependent regulation of pest populations. Once a natural enemy is successfully established, it continues to suppress the target pest without the need for repeated applications or continuous financial investment. This creates a permanent and self-sustaining solution that maintains the ecological balance within the specific agricultural or natural environment.

NODIA

6. (A) Both A and R are true and R is the correct explanation of A.
Natural enemies often struggle in frequently disturbed annual cropping systems because agricultural practices like deep plowing and harvesting disrupt their habitat and life cycles. Perennial systems offer more stability, allowing for the long-term establishment of predator and parasitoid populations. Consequently, the lack of environmental continuity in short-term crops significantly hinders the effectiveness and persistence of many biological control agents.

7. (D) Harry S. Smith
Harry S. Smith is historically credited with formally coining the term biological control in 1919 to describe the use of natural enemies to suppress pest populations. While the practice existed earlier, his terminology helped define the field as a distinct scientific discipline. This contribution provided a conceptual framework for the systematic study and application of entomophagous organisms.

8. (A) F. Muir - Pioneered the large-scale inundative release of Trichogramma
F. Muir is primarily recognized for his work in Hawaii, particularly in the successful biological control of the sugarcane leafhopper using an egg predatory bug. The large-scale inundative release of Trichogramma is associated with other researchers and later commercial developments. Distinguishing the specific contributions of pioneers helps clarify the historical evolution of various strategies within the field of entomology.

9. (A) P-2, Q-4, R-1, S-3
The history of biological control is marked by significant milestones, starting with the control of cottony cushion scale in California using the Vedalia beetle in 1889. The successful suppression of prickly pear cactus in Australia occurred in 1925. Encarsia formosa became a standard for greenhouse whitefly control, while the IOBC remains the primary international organization coordinating global efforts.

10. (B) The accidental introduction of the pest without its co-evolved natural enemies
The catastrophic outbreak of the cottony cushion scale in California was caused by its accidental introduction from Australia without its co-evolved natural enemies. In the absence of specialized predators and parasitoids, the pest population grew unchecked, threatening the entire citrus industry. This scenario perfectly illustrates the fundamental ecological principle that invasive species often explode when released from regulation.

11. (A) Its short generation time compared to its prey and high prey specificity
The rapid success of the Vedalia beetle in suppressing the cottony cushion scale was due to its high host specificity and its short generation time relative to its prey. These biological attributes allowed the beetle population to expand quickly and focus exclusively on the target pest. Such efficient reproductive and searching capabilities are essential for effective classical biological control agents.

12. (B) Introduction of Vedalia beetle → Coining of the term "Biological Control" → Formation of IOBC → Publication of Silent Spring
The chronological development of the field began with the historic introduction of the Vedalia beetle in 1889, followed by Harry Smith coining the specific term in 1919. The formal establishment of the International Organization for Biological Control occurred in the mid-twentieth century. Finally, the publication of Silent Spring in 1962 catalyzed modern integrated pest management by highlighting hazards.

13. (D) It highlighted pesticide damage, shifting focus to integrated biological methods.
Rachel Carson's Silent Spring significantly influenced the field by documenting the widespread environmental and health damage caused by synthetic chemical pesticides. This exposure shifted scientific and public focus toward more sustainable and integrated biological methods of pest suppression. Her work essentially created the necessary social and political environment for the growth of modern integrated pest management strategies worldwide.

14. (C) Early biological control efforts relied heavily on the genetic engineering of parasitoid wasps.
While early biological control efforts date back centuries, they relied on observational knowledge and the physical movement of natural enemies rather than genetic engineering. The use of predatory ants in ancient China and early observations of parasitoid emergence provided the foundation for the field. Modern biotechnology and genomic tools were only integrated into these programs much later in history.

15. (A) I, II and IV
Parasitoids are classified based on the host stage they attack and emerge from. Egg parasitoids complete development within the host egg, while larval-pupal parasitoids oviposit in larvae but emerge from pupae. Similarly, egg-larval parasitoids utilize both stages for their development. However, adult parasitoids are not exclusively ectoparasitic, as many species develop internally within the adult bodies.

16. (D) Gregarious parasitoids
Gregarious parasitoids are characterized by their ability to lay multiple eggs into a single host individual, allowing many offspring to develop and emerge simultaneously. This strategy differs from solitary parasitoids, where only one individual can successfully complete its lifecycle within a host. Such reproductive behavior is an adaptation to maximize the utilization of larger host resources for the progeny.

17. (A) A parasitoid kills its host as a normal part of development.
A fundamental biological distinction is that a parasitoid invariably kills its host as a natural part of its larval development. In contrast, true parasites usually do not kill their hosts, as their survival depends on the host remaining alive. This lethal nature makes parasitoids highly effective agents for biological control, as they directly reduce target pest populations.

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18. (C) Koinobionts allow host growth post-attack while idiobionts paralyze the host.
The primary difference in developmental physiology lies in how these parasitoids interact with host growth. Idiobionts typically paralyze the host immediately at the time of oviposition, preventing any further development or feeding. Conversely, koinobionts allow the host to continue growing, molting, and feeding for a period after being parasitized. This allows the koinobiont to exploit larger host resources.

19. (A) Idiobiont - Ectoparasitic development, broad host range, permanent host paralysis
Idiobionts are generally characterized by an ectoparasitic life-history strategy and the induction of permanent host paralysis during oviposition. They often exhibit a relatively broad host range because they do not need to overcome a living host's active physiological defenses. These parasitoids typically target hosts that are in concealed or protected microhabitats, such as pupae or wood-boring larvae.

20. (D) Adult female
In the life cycle of most Hymenopteran parasitoids, the adult female is primarily responsible for locating suitable habitats and specific hosts for her offspring. She utilizes complex sensory mechanisms, including chemical and visual cues, to ensure that eggs are placed in or on an appropriate host. This searching behavior is a critical determinant of overall biological control efficiency.

21. (A) P-1, Q-3, R-4, S-2
Different families of parasitoids specialize in attacking specific life stages of their insect hosts. For instance, members of the Trichogrammatidae and Mymaridae are predominantly egg parasitoids. Braconids often target larval stages, while Chalcidids frequently focus on pupae. Understanding these host-stage associations is essential for selecting the appropriate natural enemy to target a specific pest during its vulnerable phase.

22. (C) The ability to evade or suppress the host's cellular immune response.
Koinobiont endoparasitoids must possess specialized mechanisms to evade or suppress the host's cellular immune response, particularly encapsulation. Because the host remains alive and physiologically active during the parasitoid's development, the immature stages are vulnerable to attack by hemocytes. Successful koinobionts often utilize venoms, polydnaviruses, or molecular mimicry to neutralize these host defenses and ensure their own survival.

23. (D) Koinobionts have narrower ranges due to complex physiological interactions.
Koinobionts generally exhibit a narrower host range compared to idiobionts due to the complex physiological and immunological interactions required for their development. Since they live inside a growing host, they must be highly adapted to the specific internal environment and defenses of that species. This high degree of specialization often makes koinobionts very effective and predictable agents.

24. (A) I, II and IV
Parasitoids utilize various physiological strategies to manipulate host biology, such as the injection of polydnaviruses by certain braconids to suppress immunity. Specialized cells called teratocytes may also be involved in absorbing nutrients or altering host metabolism. Many koinobionts further manipulate host endocrinology to delay pupation, ensuring sufficient time for their own development. These mechanisms help overcome defenses.

25. (B) They induce complex alterations in host behavior post-parasitization.
Idiobiont parasitoids typically do not induce complex behavioral alterations in their hosts because they permanently paralyze them at the time of oviposition. Their strategy involves arresting host development immediately to create a stable, non-defensive food resource. Most idiobionts develop as ectoparasitoids on hosts found in concealed locations, relying on specialized venoms to ensure the host remains incapacitated.

26. (B) Koinobionts attack early instars while completing development later.
A significant applied advantage of koinobiont parasitoids is their ability to attack early host instars while completing their development later. This allows the natural enemy to establish itself within the pest population before significant damage occurs. Their specialized nature and dependence on host growth often lead to high levels of host specificity, which is desirable for minimizing non-target effects.

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(A) Cards should be stapled to the upper surface of the topmost leaves in direct sunlight.
(B) Cards should be stapled on leaf undersides in the middle canopy for protection.
(C) Cards should be deployed precisely when the pest reaches the late pupal stage.
(D) Cards must be thoroughly soaked in chemical insecticides before placement.

NODIA

2001

160. The Mexican beetle, Zygogramma bicolorata, was introduced into India in 1983. It has since established widely and is an important defoliating agent for the biological suppression of:
(A) Water hyacinth (Eichhornia crassipes)
(B) Lantana bush (Lantana camara)
(C) Siam weed (Chromolaena odorata)
(D) Congress grass (Parthenium hysterophorus)

****

common in both superparasitism and multiple parasitism, serving to determine which individual will ultimately emerge from the host.

37. (B) Reduce the population and efficacy of primary parasitoids regulating the pest
Hyperparasitoids are considered highly detrimental in classical biological control because they attack and reduce the populations of primary parasitoids. By suppressing the natural enemies that regulate the pest, hyperparasitoids can lead to increased pest densities and decreased control efficacy. Consequently, extreme care is taken during quarantine to ensure that no hyperparasitoids are accidentally introduced along with intended agents.

38. (C) A facultative hyperparasitoid
A facultative hyperparasitoid is an organism that can develop either as a primary parasitoid on an herbivore or as a secondary parasitoid on another natural enemy. This flexibility in host choice depends largely on the availability of different hosts in the environment. This opportunistic life-history strategy allows the species to maintain its population even when primary host densities fluctuate.

39. (D) Ichneumonidae have two recurrent forewing veins; Braconidae have one or none.
Adult specimens of the family Ichneumonidae can be distinguished from Braconidae primarily by their wing venation. Specifically, Ichneumonids possess two recurrent veins in the forewing, whereas Braconids have only one or none. This morphological feature is a reliable diagnostic characteristic used by entomologists to identify and separate these two closely related and economically important families in the Hymenoptera.

40. (A) Primary: Cotesia; Hyperparasitoid: Lysibia
A well-known example of a primary parasitoid and its associated hyperparasitoid is the relationship between the genus Cotesia and Lysibia. While Cotesia species are important agents for controlling various lepidopteran pests, they are frequently targeted by Lysibia wasps, which develop within the Cotesia cocoons. This relationship illustrates the multiple trophic levels that exist within the natural enemy communities.

41. (B) Releasing strong aggregation pheromones from cocoons to attract secondaries.
Primary parasitoids have evolved various strategies to minimize hyperparasitism, such as rapid development and concealing their cocoons in hidden habitats. Some species also benefit from remaining within the tough exoskeleton of their dead host for protection. However, releasing strong aggregation pheromones from cocoons would be counterproductive, as it would likely attract more secondary natural enemies rather than providing defense.

42. (A) P-2, Q-4, R-1, S-3
The hierarchy of parasitism includes primary parasitoids that attack pests and secondary parasitoids that target the primary ones. Tertiary parasitism involves a third level where an agent develops on a secondary parasitoid. A unique case is autoparasitism, where males of certain species develop as hyperparasitoids on the females of their own species, demonstrating remarkable diversity in life-history strategies.

43. (A) Aphelinidae
Adelphoparasitism, or heteronomous hyperparasitism, is a unique biological phenomenon specifically characteristic of the family Aphelinidae. In these species, females develop as primary parasitoids of hosts like whiteflies, while males develop as hyperparasitoids on females of their own or different species. This complex reproductive strategy requires highly specialized host-selection behaviors and has significant implications for mass rearing and efficacy.

44. (C) Specialized egg parasitoids of various insect orders.
Members of the family Trichogrammatidae are exclusively recognized as specialized egg parasitoids that target a wide range of insect orders, particularly Lepidoptera. Their extremely small size allows them to complete their entire development within the tiny confines of an insect egg. This attribute makes them some of the most widely utilized and commercially successful natural enemies for augmentative biocontrol worldwide.

45. (B) I, III and IV
The family Braconidae is one of the most species-rich groups of parasitoids and includes many vital biocontrol genera such as Cotesia and Aphidius.

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Many species are known for spinning distinctive silken cocoons after emerging from their hosts. While they exhibit diverse life histories, they are generally not ectoparasitoids of adults, as many are endoparasitic in larvae or eggs.

46. (C) Geniculate (elbowed) antennae and highly reduced wing venation
The superfamily Chalcidoidea is primarily identified by its geniculate, or elbowed, antennae and highly reduced wing venation. These minute wasps are among the most important groups for biological control, attacking various life stages of diverse insect pests. Their characteristic morphology helps distinguish them from other Hymenopterans, facilitating their study and use in integrated pest management programs across ecosystems.

47. (B) Emerge as adults with their full lifetime complement of mature eggs
Pro-ovigenic parasitoids differ from synovigenic species in that the females emerge as adults with their entire lifetime complement of mature eggs already developed. They do not require additional nutrient intake or host feeding to mature further eggs. This strategy often results in a shorter adult lifespan focused on rapid oviposition, whereas synovigenic species mature eggs throughout their adult life.

48. (A) Order Hymenoptera → Superfamily Chalcidoidea → Family Trichogrammatidae
The genus Trichogramma belongs to the order Hymenoptera and the superfamily Chalcidoidea. Within this group, it is classified under the family Trichogrammatidae, which is characterized by its minute size and specialization as egg parasitoids. Correct taxonomic classification is essential for the precise identification of these agents, which is a fundamental requirement for successful and safe biological control implementation.

49. (A) Mymaridae - Generally large wasps that attack the adult stage of large Lepidoptera
Mymaridae, commonly known as fairy flies, are among the smallest insects and are specialized egg parasitoids, often targeting the eggs of Hemipterans and other groups. They do not attack the adult stage of large Lepidoptera, which would be inconsistent with their minute size. Other families like Evaniidae and Encyrtidae are correctly associated with cockroach oothecae and scale insects.

50. (C) They deposit macrotype eggs on hosts or microtype eggs on host plants.
Tachinidae, a large family of predatory flies, utilize diverse oviposition strategies to ensure their larvae reach a host. Some species deposit large macrotype eggs directly onto the host's body, while others lay minute microtype eggs on host plants to be ingested by feeding larvae. This versatility in host location and infection mechanisms makes Tachinids highly effective natural enemies.

51. (C) A is true but R is false.
Predatory insects are generally defined by their need to consume multiple prey individuals throughout their development to reach maturity. However, the claim that they are significantly smaller than their prey is incorrect; most predators are actually larger or more powerful than their individual prey items. This allows them to effectively capture and overcome multiple hosts, distinguishing them from parasitoids.

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52. (B) Oligophagous
A predator that has evolved to feed almost exclusively on a single species or a few closely related species within the same genus is termed monophagous, while those feeding on a few species are oligophagous. This high degree of specialization is relatively rare among predators but can be very effective. Highly specialized natural enemies provide the advantage of host specificity.

53. (B) Predators kill prey quickly; parasitoids allow hosts to live and feed.
A fundamental biological difference is that predators typically kill and consume their prey quickly, whereas parasitoids allow their hosts to remain alive and continue feeding for a period during the parasitoid's development. Additionally, predators require multiple prey individuals to complete their life cycle, while a single host is usually sufficient for one or more parasitoids. These strategies influence regulation.

54. (A) P-2, Q-3, R-4, S-1
Different groups of predatory insects exhibit varied life-history patterns regarding which stages are carnivorous. For example, both nymphs and adults of mantises are predatory, while in hoverflies, only the larvae are predatory. Dragonflies have aquatic predatory naiads and aerial predatory adults. Coccinellids are well-

known for having both larvae and adults that actively hunt and consume pests like aphids.

55. (D) They can sustain their populations on alternative prey or plant resources when the primary pest density is low.
Polyphagous predators offer a significant advantage in biological control by their ability to sustain populations on alternative prey or plant resources when the primary pest density is low. This persistence ensures that a natural enemy population is already present in the environment when a pest outbreak begins. This generalist feeding strategy contributes to the overall stability and resilience of ecosystems.

56. (A) They pose a high risk of attacking non-target, beneficial, or endemic species.
The primary ecological risk associated with releasing highly polyphagous exotic predators is their potential to attack non-target, beneficial, or endemic species. Because they lack host specificity, they may disrupt native food webs and threaten biodiversity beyond the targeted pest. This concern is a major factor in the rigorous environmental impact assessments required before the introduction of any new generalist.

57. (B) I, III and IV
Effective predators for augmentation programs should possess high searching capacity and a high prey consumption rate to rapidly reduce pest populations. Additionally, the ease of mass rearing on factitious prey or artificial diets is a critical practical requirement for commercial viability. While high host specificity is ideal for safety, many successful augmentative agents are somewhat polyphagous in the field.

58. (B) Soft-bodied Hemipterans like aphids and mealybugs.
Most species within the family Coccinellidae, or ladybird beetles, are specialized predators of soft-bodied Hemipteran insects such as aphids, mealybugs, and scales. Their both larval and adult stages are voracious consumers of these pests, making them some of the most recognizable and effective agents in biological control. Their presence in agricultural fields is often a key indicator of regulation.

59. (A) Reduviidae - Assassin bugs, ambush predators with a raptorial rostrum.
Reduviidae, commonly known as assassin bugs, are predatory Hemipterans that utilize a raptorial rostrum to capture and pierce their prey. They are mostly generalist predators found in various habitats. Other families like Carabidae and Chrysopidae are also important, but their common names and behaviors are often confused; for instance, Chrysopidae are green lacewings and Carabidae are ground beetles.

60. (D) I, II and III
Ground beetles belonging to the family Carabidae are predominantly nocturnal, soil-dwelling predators that play a crucial role in regulating soil pests and even consuming weed seeds. Both the larval and adult stages are typically predatory, contributing to their effectiveness in conservation biological control. Enhancing their habitats through practices like beetle banks can significantly improve the natural suppression of pests.

61. (D) They inject enzymes and suck out liquefied contents via extra-oral digestion.
Predatory Hemipterans, such as assassin bugs and minute pirate bugs, utilize extra-oral digestion to consume their prey. They use their specialized mouthparts to inject potent enzymes into the host, which liquefy the internal tissues. The resulting nutrient-rich fluid is then sucked out through the rostrum. This efficient feeding mechanism allows them to overcome and utilize prey that may be larger.

62. (C) Syrphidae - Hymenoptera
Syrphidae, commonly known as hoverflies, belong to the order Diptera rather than Hymenoptera. Their larvae are important predators of aphids, while the adults are well-known for their hovering flight and role as pollinators. Correctly identifying the order of these natural enemies is fundamental for understanding their biology, life cycles, and the specific ecological niches they occupy within agricultural environments.

63. (B) II and III
Hoverflies play a unique dual role in agroecosystems as their adults are important pollinators that feed on nectar and pollen, while their maggot-like larvae are obligate predators of soft-bodied insects like aphids. This makes them highly beneficial for both crop production

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of insect density by collecting all individuals from a specific, measured area of the crop. This differs from relative methods like sweep netting or sticky traps, which provide data that depend on insect behavior. Absolute estimates are essential for precise population monitoring and for accurately calculating impact.

135. (D) Absolute estimates provide density per area; relative depends on trap efficiency.
The primary difference between these sampling methods is that absolute estimates provide a direct measurement of insect density per unit of area, whereas relative estimates depend on the efficiency of the trap and the behavior of the insects. Absolute methods are more precise but often more labor-intensive, while relative methods are easier to implement. Both are valuable tools for understanding population dynamics.

136. (A) Comparing total light trap catches of parasitoids to total catches of pests.
Comparing total light trap catches of parasitoids to those of pests is a flawed technique for evaluating true percent parasitism because trap efficiency varies greatly between species and sexes. More reliable methods include rearing field-collected larvae in the laboratory or performing diagnoses to directly observe immature parasitoids. Molecular markers are also increasingly used to accurately identify parasitism in early stages.

137. (A) Both A and R are true and R is the correct explanation of A.
Exclusion cages are an effective experimental tool because the fine mesh physically prevents naturally occurring predators and parasitoids from reaching the pests inside the cage. This often results in significantly higher pest populations within the cages compared to unprotected areas of the same plant. This difference clearly demonstrates the regulatory impact that the natural enemy complex has on the pest population.

138. (A) 30%
The apparent percent parasitism is calculated by dividing the number of parasitized individuals by the total sample size and multiplying by one hundred. In this scenario, thirty out of one hundred collected pupae yielded parasitoids, resulting in a parasitism rate of thirty percent. This metric provides a snapshot of the impact that natural enemies are having on the pest population.

139. (A) International Organization for Biological Control
The IOBC stands for the International Organization for Biological Control, a global body dedicated to promoting environmentally safe and sustainable pest management. It coordinates international research and cooperation in the field of biological control and integrated pest management. The organization plays a vital role in setting standards, sharing knowledge, and advocating for natural enemies as a primary tool for protection.

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140. (C) CIBRC - Registration and regulation of biopesticides in Indian agriculture.
The Central Insecticides Board and Registration Committee (CIBRC) is the nodal regulatory body in India responsible for the registration and regulation of all pesticides, including biopesticides. This ensures that biological control products meet the necessary safety and efficacy standards before they can be commercially sold. Other organizations focus more on research, development, and the provision of technical support.

141. (A) I and II
CABI is an international, intergovernmental organization that has historically played a major role in global exploration and classical biological control programs. It also maintains extensive open-access databases and compendiums that provide essential information for agricultural researchers worldwide. While it operates on a global scale, it is not restricted to any single continent, reflecting its mission to improve food security.

142. (A) P-2, Q-1, R-4, S-3
Various national and international organizations coordinate biological control efforts, such as NBAIR in Bengaluru, which is the nodal agency for insect resource research in India. The IOBC is a global organization promoting safe pest control, while CABI is heavily involved in international classical biological control programs. The CIBRC serves as the primary regulatory body overseeing the legal framework for biopesticides.

73. (B) Fungi penetrate the cuticle via enzymes; bacteria and viruses require ingestion.
Entomopathogenic fungi are unique because they can initiate infection by penetrating the insect cuticle directly using mechanical pressure and specialized enzymes. In contrast, most entomopathogenic bacteria and viruses must be ingested by the host to cause disease. This ability to enter through the integument allows fungi to infect a wide range of insects, including those with sucking mouthparts.

74. (B) High ambient relative humidity for conidial germination
The field efficacy of entomopathogenic fungi like Beauveria bassiana is heavily dependent on high ambient relative humidity for the successful germination of conidia on the host cuticle. Without sufficient moisture, the spores cannot initiate the infection process, leading to inconsistent results in dry environments. This critical requirement is a major consideration when timing applications for fungal biopesticide use.

75. (A) I and II
The infection process of entomopathogenic fungi involves several key steps, beginning with the adhesion of conidia to the host epicuticle. This is followed by the formation of an appressorium and a penetration peg that allows the fungus to enter the host's body. Once inside, the fungus replicates within the hemolymph and various tissues, eventually leading to host death.

76. (C) Xenorhabdus and Photorhabdus
Entomopathogenic nematodes in the families Steinernematidae and Heterorhabditidae rely on a mutualistic relationship with bacteria from the genera Xenorhabdus and Photorhabdus, respectively. After entering a host, the nematodes release these bacteria, which quickly kill the insect and provide a nutrient-rich environment for the nematodes to reproduce. This partnership is essential for the rapid lethal action of these agents.

77. (A) Both A and R are true and R is the correct explanation of A.
The third-stage Infective Juvenile is the only free-living stage of entomopathogenic nematodes capable of surviving outside a host in the soil environment. This stage is morphologically and physiologically adapted to withstand environmental stressors while actively searching for new hosts. It also carries the mutualistic bacteria necessary for killing the host, making it the critical stage for environmental persistence.

78. (C) Metarhizium anisopliae - Green muscardine disease
Metarhizium anisopliae is the causative agent of green muscardine disease, named for the characteristic green color of the spores that eventually cover the host cadaver. Other fungi cause similarly named diseases, such as Beauveria bassiana causing white muscardine. These names are based on the visual appearance of the fungal growth, which is a key diagnostic feature for pathogens.

79. (A) P-2, Q-3, R-4, S-1
Biological control agents exhibit various specialized strategies, such as the ambush foraging of certain Steinernema nematodes and the cruiser strategy of Heterorhabditis. Bacterial pathogens like Bacillus sphaericus are highly effective in specific environments like polluted water for mosquito control. Additionally, specialized fungi like Metarhizium acridum have been developed as targeted biopesticides for managing outbreaks of locusts and grasshoppers.

80. (D) The soil is adequately moist before, during, and after application to prevent desiccation.
When applying entomopathogenic nematodes to the field, maintaining adequate soil moisture is crucial for their survival and movement. As aquatic organisms, they require a film of water to travel through the soil and locate their hosts. Desiccation is a major cause of failure in EPN applications, so ensuring the soil remains moist is essential for maximizing their field efficacy.

81. (A) The host plant, the herbivorous pest, and the natural enemy
A tritrophic interaction specifically involves the complex ecological and chemical relationships between three trophic levels: the host plant, the herbivorous pest, and the natural enemy. This framework recognizes that the plant can significantly influence the interaction between the herbivore and its predators or parasitoids. Understanding these linkages is vital for developing effective biological control strategies that leverage plant defenses.

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like Beauveria are applied in high doses for immediate knockdown, while the Sterile Insect Technique utilizes non-reproductive males to crash a population. Each method is tailored to specific biology.

100. (D) Inundative augmentation
In Indian agriculture, the egg parasitoid Trichogramma chilonis is predominantly utilized through inundative augmentation to manage sugarcane borers. This involves the regular release of large numbers of the wasp using tricho-cards to ensure a high rate of parasitism across the crop. This strategy has become a standardized and effective component of integrated pest management for sugarcane in many regions.

101. (B) It requires a continuous and economically viable mass-rearing infrastructure.
A significant operational constraint specific to inundative biological control is the requirement for a continuous and economically viable mass-rearing infrastructure. Because large numbers of natural enemies must be produced and released regularly, the success of the program depends on the efficiency of the insectary. This need for constant production can make inundative control logistically challenging compared to other forms.

102. (C) Inoculative releases work well for pests with overlapping greenhouse generations.
The choice between different augmentation methods is influenced by the voltinism and generational patterns of the target pest. For example, inoculative releases are highly effective in greenhouse environments where pests have overlapping generations, as a small initial population of natural enemies can continuously reproduce. Understanding these life-cycle dynamics is essential for designing an effective and sustainable biological control program.

103. (D) Manipulating habitats to enhance the survival and success of resident natural enemies.
Ecological engineering in the context of conservation biological control refers to the deliberate manipulation of agricultural habitats to enhance the survival, reproduction, and efficacy of resident natural enemies. This approach involves providing essential resources such as food, shelter, and overwintering sites. By making the landscape more favorable for beneficial organisms, farmers can increase the natural suppression of pests without external inputs.

104. (A) Both A and R are true and R is the correct explanation of A.
Beetle banks are raised earth ridges sown with native grasses that serve as undisturbed overwintering refuges for predatory beetles within large crop monocultures. These habitats protect the beneficial insects from agricultural disturbances and provide a source from which they can migrate into the field. By integrating such structures, farmers can significantly enhance the resident natural enemy populations and control capacity.

105. (B) Repellent intercrops and attractive trap crops used together.
The Push-Pull strategy for managing stem borers in Africa utilizes a combination of repellent intercrops and attractive trap crops to protect the main maize crop. Repellent plants push adult pests away from the crop, while attractive border plants pull them toward a sacrificial site. This integrated approach leverages plant-insect interactions to achieve effective and sustainable pest management without synthetic chemicals.

106. (B) I, II and III
A functional banker plant system involves growing a non-crop plant that supports an alternative, non-pest herbivore, which in turn serves as a food source for a mass-reared natural enemy. This setup allows the natural enemy population to sustain itself within the greenhouse even when the primary pest density is low. This provides a continuous and reliable source of biological control agents.

107. (A) Providing accessible floral resources like Alyssum as nectar sources.
Providing accessible floral resources, such as Alyssum, in and around crop fields is a direct way to increase the longevity and fecundity of adult Braconid parasitoids. These flowers provide essential nectar and pollen that serve as food sources for the adult wasps. By improving the nutritional status of natural enemies, farmers can enhance their overall reproductive success and pest control effectiveness.

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introduced, protecting native biodiversity and agricultural systems.

91. (A) I, II, III and IV
When selecting an exotic natural enemy for classical biocontrol, several key principles are considered, including high host specificity and climatic adaptation to the release area. The agent should also have high reproductive potential and excellent searching capability even at low host densities. However, an agent that acts as a hyperparasitoid would be undesirable, as it could disrupt the complex.

92. (C) Stable habitats allow natural enemies to establish without annual disturbances.
Classical biological control programs often achieve higher success rates in stable habitats like orchards and forests because these environments allow natural enemies to establish without frequent agricultural disturbances. In contrast, annual row crops are subject to regular harvesting and tilling, which can disrupt the life cycles and habitats of beneficial organisms. Perennial systems provide the necessary long-term stability.

93. (D) A sessile or slow-moving exotic pest infesting perennial plant systems.
An invasive pest is considered a promising candidate for classical biological control if it is an exotic, relatively sessile species infesting a perennial plant system. The lack of mobility makes it easier for natural enemies to locate and suppress the population, while the stable environment facilitates permanent establishment. Historically, many spectacular successes have involved these types of pest-host scenarios.

94. (A) Both A and R are true and R is the correct explanation of A.
During the quarantine phase of a biological control program, any hyperparasitoids found in imported shipments must be meticulously identified and destroyed. This is because the accidental introduction of secondary natural enemies can severely disrupt the efficacy of the primary parasitoid and negatively impact native biological control agents. Ensuring that only primary natural enemies are released is a fundamental requirement.

95. (B) Inoculative Augmentation
Inoculative augmentation involves the release of natural enemies with the expectation that they will multiply and provide pest control over several generations within a single growing season. Unlike classical biocontrol, it does not necessarily aim for permanent establishment in the environment. This strategy is often used when the natural enemy cannot survive the winter or when systems are disturbed.

96. (D) Inundative releases use massive numbers of agents for rapid, immediate pest suppression, akin to a biotic pesticide.
Inundative biological control involves the release of massive numbers of natural enemies for rapid and immediate pest suppression, functioning much like a biotic pesticide. In contrast, inoculative releases rely on the subsequent generations of the released agents to provide control. Inundative strategies prioritize the immediate impact of the released individuals themselves rather than their long-term establishment in the field.

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97. (A) The pest is at the economic threshold and requires immediate suppression.
An inundative release is strongly justified when a pest population has already reached the economic threshold and requires immediate suppression to prevent crop damage. In such scenarios, the rapid knockdown effect provided by massive numbers of natural enemies is essential. This approach is particularly useful for short-cycle crops where there is insufficient time for an inoculative population to build up.

98. (A) I and II
The commercial success of inundative biological control is favored by the availability of cost-effective, large-scale mass-rearing technologies and its suitability for short-cycle crops where permanent establishment is not possible. Since these programs rely on the immediate impact of the released agents, they do not require the natural enemies to establish multi-year populations. This makes inundative control a flexible tool.

99. (A) P-2, Q-1, R-3, S-4
Augmentative biological control encompasses various strategies, such as the regular inundative release of Trichogramma to destroy egg masses and the early-season inoculative release of predatory mites in greenhouses. Microbial agents

82. (C) They are specific signals that attract natural enemies to the damaged plant.
Herbivore-Induced Plant Volatiles are chemical signals emitted by a plant when it is being fed upon by an herbivore. These volatiles serve as cries for help that attract natural enemies, such as parasitoids and predators, to the source of the damage. This indirect defense mechanism benefits the plant by reducing herbivory and the natural enemy by providing a cue.

83. (A) I, II and IV
Various plant morphological traits can significantly influence the success of biological control agents. Glandular trichomes can physically entrap small parasitoids, and thick cuticular waxes may prevent the adhesion of predatory eggs. While complex leaf architectures can provide refuges for pests, other features can benefit the system. These interactions highlight the importance of plant characteristics in determining pest suppression.

84. (D) Control of pests via plant nutritional quality and secondary defense chemicals.
In ecological theory, bottom-up regulation refers to the limitation of herbivore populations by the quality and availability of their primary food source, the plant. This includes the influence of plant nutritional content and the presence of secondary defense chemicals that may inhibit herbivore growth or survival. This contrasts with top-down regulation, which is driven by the mortality from natural enemies.

85. (B) The gravitational pull affecting sap flow dynamics
While chemical signaling through kairomones, synomones, and pheromones is central to tritrophic interactions, abiotic factors like gravitational pull are generally irrelevant to these specific ecological linkages. The focus of tritrophic research is on how biochemical cues mediate the communication between plants, herbivores, and natural enemies. Understanding these signals allows for the manipulation of the environment to enhance biocontrol.

86. (C) Synomone
A synomone is a semiochemical substance emitted by an individual of one species that evokes a response in another species, providing an adaptive advantage to both. A classic example is the emission of volatiles by a damaged plant that attracts a parasitoid. This interaction benefits the plant by reducing herbivivore damage and the parasitoid by helping it find a host.

87. (A) Both A and R are true and R is the correct explanation of A.
The emission of Herbivore-Induced Plant Volatiles is often considered an evolutionary mutualism because it provides clear benefits to both the plant and the natural enemy. The plant experiences a reduction in pest-inflicted damage, while the parasitoid gains a reliable and specific chemical cue to locate its host efficiently. This strategy demonstrates how chemical communication shapes interactions between trophic levels.

88. (A) Exotic, self-sustaining natural enemies for the permanent regulation of invasive pests.
Classical Biological Control is defined as the intentional introduction of exotic natural enemies with the goal of establishing a self-sustaining population for the permanent regulation of invasive pests. This strategy is typically used against pests that have been accidentally introduced into a new region without their co-evolved natural enemies. Success relies on the long-term establishment and searching ability of agents.

89. (A) Foreign exploration → Quarantine screening → Field release → Post-release evaluation
The operational sequence for a classical biological control program begins with foreign exploration to identify potential natural enemies in the pest's native range. These agents are then subjected to rigorous quarantine screening to ensure they are safe and host-specific. After successful testing, they are released into the field, followed by long-term post-release evaluation to monitor their establishment.

90. (B) Immediate mass field release upon arrival - To prevent the genetic bottlenecking of the imported population
Immediate mass field release upon arrival is the opposite of proper quarantine protocol and is never performed in classical biological control. Quarantine is essential for rearing imported agents through multiple generations to eliminate hyperparasitoids and for conducting thorough host-specificity testing. These steps ensure that only safe and effective natural enemies are

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108. (C) It relies exclusively on the importation of exotic species from international quarantine facilities.
Conservation biological control focuses on protecting and enhancing the populations of existing, indigenous natural enemies rather than relying on the importation of exotic species. Key principles include reducing the use of toxic pesticides and creating structural complexity in the landscape to provide refuges. This approach aims to maximize the natural regulatory potential already present within the local ecosystem through targeted habitat management.

109. (D) Floral resources increase the longevity and reproductive success of natural enemies.
The primary ecological mechanism by which floral resources in field margins reduce pest populations is by increasing the longevity and reproductive success of natural enemies. Adult parasitoids and many predators require nectar and pollen for energy and egg maturation. By providing these essential food sources, the agricultural landscape supports a larger population of beneficial organisms that can effectively suppress pests.

110. (C) Factitious host for rearing parasitoids and predators
In the commercial mass-rearing facilities of India, the rice moth, Corcyra cephalonica, is primarily utilized as a highly effective and versatile factitious host. Its eggs and larvae are used to produce a wide range of natural enemies, including Trichogramma wasps and various predatory insects. The ease and low cost of rearing Corcyra make it a cornerstone of the biocontrol industry.

111. (A) P-3, Q-1, R-2, S-4
Different hosts and diets are used to mass-rear specific biological control agents in the laboratory. For example, Corcyra eggs are used for Trichogramma, while mealybug-infested pumpkins are ideal for rearing the predatory beetle Cryptolaemus montrouzieri. Galleria mellonella larvae are commonly used for the in vivo production of entomopathogenic nematodes. Artificial diets sustain the adult stages of green lacewings.

112. (A) II, I, III, IV
The laboratory production of Trichogramma begins with the collection of fresh eggs from the factitious host, Corcyra cephalonica. These eggs are then subjected to UV irradiation to arrest embryonic development, ensuring they remain optimal. Next, the treated eggs are glued onto tricho-cards before being exposed to adult Trichogramma in breeding jars. This sequence ensures the efficient production of wasps.

113. (B) II, III and IV
An ideal factitious host for the mass multiplication of natural enemies should be highly susceptible to the agent and inexpensive to rear year-round on non-crop substrates. It must also yield natural enemy progeny with high fitness and excellent searching capacity for effective field performance. While it does not need to be identical to the target pest, it must provide nutrition.

114. (C) To genetically modify the parasitoid offspring for higher field tolerance
Corcyra cephalonica eggs are subjected to UV radiation to kill the embryo and prevent the host from hatching, which would lead to the destruction of the eggs. This process also ensures that the internal contents of the egg remain suitable for the developing parasitoid. However, UV treatment is not used for the genetic modification of the parasitoid offspring within the rearing process.

115. (A) Larvae are highly cannibalistic and must be reared in isolated individual cells.
A major operational challenge in the mass production of Chrysoperla carnea is the highly cannibalistic nature of its larvae. To prevent them from killing each other, the larvae must be reared in individual cells or provided with sufficient space and food to minimize contact. This requirement significantly increases the labor and space needed for large-scale production, making it logistically complex.

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116. (A) Both A and R are true and R is the correct explanation of A.
Maintaining genetic diversity in laboratory-reared populations of biological control agents is essential for ensuring their field efficacy and long-term viability. Continuous inbreeding in a stable, artificial environment can lead to genetic bottlenecks and the selection of traits that are detrimental in the field, such as reduced searching behavior. Regularly introducing wild genetic stock helps mitigate these effects and preserves fitness.

and pest suppression. Providing floral resources in and around fields can attract adult syrphids, encouraging predatory larval populations.

64. (D) Chrysopidae
The term aphid lion is historically applied to the larvae of the family Chrysopidae, or green lacewings. This name reflects their voracious predatory behavior and their primary diet consisting of aphids and other small, soft-bodied insects. These larvae possess specialized, hollow mandibles used to capture prey and suck out their body fluids, making them highly effective biological control agents.

65. (A) Released adults may rapidly disperse from the target field before oviposition.
When using Chrysoperla carnea in an inundative biological control program, practitioners must account for the high dispersal tendency of the released adults. Since the adult stage is not predatory and feeds primarily on nectar and pollen, they may leave the target field before laying eggs. Consequently, releases are often timed to ensure that the predatory larval stage is present.

66. (A) II, I, IV, III
The infection process of a Nuclear Polyhedrosis Virus begins with the ingestion of viral occlusion bodies by a susceptible larva. Once in the alkaline midgut, these bodies dissolve, releasing virions that fuse with epithelial cells to begin replication. Finally, the host cells lysis, and new occlusion bodies are released into the environment as the larva liquefies, facilitating further spread.

67. (A) Both A and R are true and R is the correct explanation of A.
Bacillus thuringiensis must be ingested by the target insect because its crystalline endotoxins require activation by specific proteases found in the highly alkaline environment of the insect midgut. This process transforms the protoxin into its active form, which then binds to receptors and creates pores in the gut lining. This specificity explains why Bt is effective against certain pests.

68. (B) P-2, Q-1, R-3, S-4
Different entomopathogens produce distinct symptoms in their hosts, such as NPV causing larvae to liquefy and hang from high points. Beauveria infections result in mummified cadavers covered in a white fungal bloom. Bt infection leads to a rapid cessation of feeding, while entomopathogenic nematodes often cause the host to turn a characteristic red or ochre color due to bacteria.

69. (B) I, III and IV
Baculoviruses are double-stranded DNA viruses that are highly host-specific, often targeting only a single species or a few closely related ones. They possess protective occlusion bodies that allow them to survive in the environment until they are ingested by a host. They are considered safe for humans and non-target organisms, making them ideal candidates for sustainable agricultural pest management.

70. (C) NPV occlusion bodies contain multiple virions; GVs typically contain only one.
A primary structural difference between Nucleopolyhedroviruses and Granuloviruses lies in the number of virions contained within their occlusion bodies. NPV occlusion bodies typically contain multiple virions, whereas GV occlusion bodies usually contain only a single virion. This difference in packaging is a key characteristic used by virologists to classify and distinguish these two important groups of entomopathogenic viruses.

71. (D) Lepidoptera
Bacillus thuringiensis var. kurstaki is the most widely commercialized strain of Bt and is specifically effective against the larvae of many Lepidopteran pests. It has been extensively used to control various caterpillars in agricultural crops and forests. Its high efficacy and selectivity for lepidopteran larvae, combined with its safety profile for other organisms, make it a cornerstone of microbial control.

72. (A) The infected grub continues to feed voraciously until the moment of pupation.
In milky disease caused by Bacillus popilliae, infected grubs gradually become lethargic and eventually cease feeding as the bacteria proliferate in their hemolymph. The characteristic turbid and milky appearance of the hemolymph is due to the massive number of bacterial spores. This disease is particularly effective against certain soil-dwelling scarab beetle larvae, providing a long-term method of biological suppression.

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actively disperse and locate widely distributed pest populations. If the agents have lost their propensity to fly due to laboratory adaptation, they will be ineffective in the field. Ensuring robust flight performance is therefore a key requirement for the success of augmentation.

126. (B) I, II and III
The cost-benefit ratio of an augmentative biological control program is determined by weighing the costs of mass-rearing and application against the economic benefits of protected crop yield and reduced pesticide expenses. These factors directly influence the economic viability and adoption of biological methods by farmers. While global market trends are important, they are not typically included as direct variables in this calculation.

127. (B) Genetic sequence of the insect's mitochondrial DNA per batch
Standard quality control manuals for predatory insects focus on practical biological parameters such as adult fecundity, survivorship during shipment, and the absence of hyperparasitoids. While genetic monitoring is important for long-term health, routine laboratory genomic sequencing of every batch is not a standard operational requirement for commercial production. Instead, other metrics provide immediate and reliable indicators of the quality of natural enemies.

128. (A) P-3, Q-1, R-2, S-4
Quality control parameters for biological control agents are assessed using specific methods, such as counting the number of eggs laid to determine fecundity and using flight cylinders to measure dispersal capability. Sex ratio evaluation is critical for predicting growth, while longevity tests measure how long adults survive with food. These standardized tests ensure that produced natural enemies meet standards for field performance.

129. (A) Selection for laboratory traits like crowding tolerance over field foraging skills.
Laboratory adaptation occurs when a natural enemy population is selected for traits that are advantageous in an insectary environment, such as high tolerance for crowding. This process often comes at the expense of critical field traits like host-searching behavior and environmental resilience. To prevent this, it is essential to periodically introduce wild stock and maintain rearing conditions that reflect natural challenges.

130. (C) Releasing agents just before the economic threshold to prevent crop injury.
The economic threshold concept is compatible with augmentative biological control, where agents are released just before the pest population reaches the level that would cause economic damage. This proactive approach ensures that the natural enemies have enough time to suppress the pest before the economic injury level is exceeded. Integrating biocontrol with thresholds allows for more precise and cost-effective management decisions.

131. (B) Fecundity - The physical distance a parasitoid can fly in one hour
Fecundity refers to the reproductive potential of an organism, specifically the number of offspring or eggs produced by a female during her lifetime. It is not a measure of physical flight distance. Other terms like shelf life and economic injury level are correctly associated with their standard definitions in the context of biological control economics and quality management for pests.

NODIA

132. (D) Sampling post-release to confirm natural enemy establishment in the field.
A recovery study in biological control involves sampling the target habitat after the release of natural enemies to confirm their establishment and persistence in the field. This process is essential for evaluating the success of a classical or inoculative program and for understanding the impact of agents. By recovering natural enemies, researchers verify that they have successfully adapted to the environment.

133. (A) I, II, III and IV
Various experimental methods are used to demonstrate the efficacy of natural enemies, including exclusion cages to prevent access to pests and addition plots where agents are released. Interference methods utilize selective insecticides to eliminate natural enemies while leaving pests unharmed, and sentinel prey placement allows for direct measurement of mortality. These techniques provide robust evidence of the regulatory impact on populations.

134. (C) Calibrated vacuum (D-vac) sampling
Calibrated vacuum sampling, or D-vac, is a technique used to provide an absolute estimate

117. (B) Solid cereal substrates like rice or sorghum with optimized moisture levels.
Solid-state fermentation is a common method for the commercial production of entomopathogenic fungi like Beauveria and Metarhizium, utilizing cereal substrates such as rice or sorghum. This process involves inoculating the moist solid substrate with the fungus and providing optimal conditions for growth. It is a cost-effective approach that yields high concentrations of aerial conidia used in biopesticide formulations.

118. (C) Submerged fermentation yields blastospores; solid-state yields aerial conidia.
A key difference between submerged liquid fermentation and solid-state fermentation is the type of fungal spores produced. Submerged fermentation typically yields blastospores, which are often less stable than the aerial conidia produced by solid-state fermentation. For most commercial biopesticides, aerial conidia are preferred due to their superior environmental persistence and ease of formulation into stable products for field application.

119. (A) I and II
Formulated biopesticides often include protective additives such as UV protectants to shield the microbial agents from solar radiation and humectants to maintain the moisture necessary for spore germination. These components are essential for ensuring the stability and efficacy of the product under field conditions. Adding broad-spectrum fungicides would be counterproductive, as they would kill the entomopathogenic fungi being formulated.

120. (A) Water Dispersible Granules (WG) - Large, insoluble pellets designed to sink rapidly without water
Water Dispersible Granules are designed to break apart and disperse uniformly when added to water, rather than remaining as insoluble pellets. Other common formulations include Wettable Powders, which form a suspension, and Emulsifiable Concentrates, which contain oils for liquid application. Selecting the appropriate formulation is critical for ensuring the effective delivery and coverage of the biological control agent on crops.

121. (B) They are predominantly produced in vivo by infecting large numbers of live hosts.
Currently, the commercial production of Baculoviruses like HaNPV is predominantly achieved in vivo by infecting large numbers of live host larvae. This process involves rearing the hosts, inoculating them with the virus, and then harvesting the resulting viral occlusion bodies after the larvae have died. While in vitro methods exist, they are not yet as economically viable for large-scale production.

122. (B) Low temperature (refrigeration) and low humidity
To maximize the shelf life of a formulated bio-insecticide containing conidia of entomopathogenic fungi, the product should be stored under refrigerated conditions with low humidity. High temperatures and moisture can trigger premature germination or degradation of the spores, significantly reducing their viability over time. Proper storage is a critical factor for maintaining the quality and reliability of biological control products.

123. (A) Ensure uniform dispersion across waxy plant surfaces to improve contact.
Adjuvants like surfactants are often added to biopesticide sprays to ensure uniform dispersion and improve contact with waxy or hairy plant surfaces. These wetting agents reduce the surface tension of the spray droplets, allowing them to spread more evenly and stick to the target areas. Enhanced coverage is essential for maximizing the probability of infection by entomopathogenic fungi or nematodes.

124. (C) The percentage of emergence and proportion of females in the population.
Essential quality control metrics for mass-reared Trichogramma include the percentage of adult emergence and the proportion of females in the population. A high emergence rate ensures that the released product will provide the expected number of active natural enemies, while a female-biased sex ratio is critical for population growth. These parameters are fundamental indicators of the overall health of agents.

125. (A) Both A and R are true and R is the correct explanation of A.
Routine evaluation of flight capacity is an important quality control test for mass-reared parasitoids because they must be able to

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143. (B) Bengaluru
The National Bureau of Agricultural Insect Resources, formerly known as the Project Directorate of Biological Control, is headquartered in Bengaluru. As a key institution under the Indian Council of Agricultural Research, it coordinates national efforts in the biosystematics, conservation, and utilization of beneficial insects. The bureau plays a critical role in providing starter cultures and research leadership for India.

144. (D) Bypassing all international quarantine laws to fast-track exotic agent importation
National organizations like NBAIR are legally and operationally bound by international and national quarantine laws when importing exotic agents. Bypassing these protocols would be a severe violation and pose significant ecological risks. Their actual mandate includes maintaining repositories of biocontrol agents and conducting research on indigenous species. These activities are performed within a strict regulatory framework to ensure safety.

145. (A) Both A and R are true and R is the correct explanation of A.
Classical biological control inherently requires international cooperation because the process of exploring for, exporting, and importing natural enemies involves crossing multiple national borders. Formal legal frameworks and quarantine protocols are essential to ensure the safe movement of these organisms and to prevent the accidental introduction of unwanted species. This collaborative approach is fundamental to the success of global biocontrol.

146. (C) The moth Cactoblastis cactorum
The spectacular biological control of the invasive prickly pear cactus in Australia was achieved through the introduction of the moth Cactoblastis cactorum. The larvae of this moth feed extensively on the internal tissues of the cactus pads, causing the plants to collapse and rot. This success is one of the most famous examples of classical biological control of an invasive weed.

147. (B) I, II and III
The historic success of the Vedalia beetle against the cottony cushion scale was due to excellent climatic matching between its native range and the introduction site, as well as its high specific predation rate. Its strong dispersive capacity also allowed it to quickly spread and locate new pest patches. These combined attributes enabled the beetle to achieve rapid and permanent suppression.

148. (D) Gypsy moth (Lymantria dispar) - Cactoblastis cactorum
While Cactoblastis cactorum is the renowned agent for the biological control of prickly pear cactus, it is not used for managing the gypsy moth. Other pairings like the cassava mealybug with Apoanagyrus lopezi and the Salvinia weed with Cyrtobagous salviniae represent highly successful and well-documented classical biological control programs. Correctly identifying these specific agent-pest relationships is essential for understanding history.

149. (B) Larvae hollow out pads, allowing secondary rot to collapse the plant.
The lethal impact of Cactoblastis cactorum on the prickly pear cactus is due to the larval behavior of hollowing out the cactus pads. This extensive feeding not only destroys the plant tissues but also allows secondary rot-inducing pathogens to enter and collapse the structure. This combination of direct herbivory and indirect disease facilitates the rapid and complete destruction of the weed.

NODIA

150. (C) Winter moth control in Canada using specialized parasitoids.
The control of the winter moth in Canada using specialized parasitoids is a classic and highly successful example of biological control targeting an insect pest rather than a weed. This program involved the introduction of natural enemies from the moth's native range, which established and provided long-term suppression. This success highlights the effectiveness of classical biocontrol in managing invasive forest insects.

151. (D) Successful classical biocontrol can operate on a continental scale in Africa.
The cassava mealybug control program using the parasitoid Apoanagyrus lopezi demonstrated that successful classical biological control can operate effectively on a continental scale in Africa. By releasing the wasps across a vast geographic area, researchers achieved widespread and sustainable suppression of a devastating pest. This historic program provided a model

2024

46. What distinguishes systemic insecticides, like imidacloprid, from translaminar insecticides, like abamectin, regarding their movement within plant tissues?
(A) Translaminar insecticides move freely through xylem vessels to protect new foliage, whereas systemics only stay on the surface.
(B) Systemic insecticides are primarily transported through the phloem, while translaminar insecticides only utilize xylem vessels.
(C) Systemic insecticides move via the xylem to unsprayed parts, while translaminar ones move locally across leaf surfaces.
(D) There is no functional or physiological difference; both terms define identical patterns of movement within the plant tissue.

2008

47. Which of the following terms correctly identifies the synergistic action where two non-toxic compounds, when mixed together, produce significant toxicity to an insect?
(A) Additive effect
(B) Coalitive action
(C) Antagonism
(D) Potentiation

2003

48. Identify the correct pair of a botanical insecticide and its primary botanical source plant.
(A) Pyrethrin — Azadirachta indica
(B) Pongamin — Chrysanthemum cinerariifolium
(C) Nicotine — Milletia pinnata
(D) Rotenone — Derris elliptica

2021

49. Why is the aging process of phosphorylated acetylcholinesterase clinically significant in organophosphate poisoning?
(A) It involves loss of an alkyl group, making the OP-enzyme bond irreversible and resistant to oximes.
(B) It results in the rapid and spontaneous reactivation of the enzyme, eliminating the medical requirement for antidotes.
(C) It indicates that the organophosphate molecule has been completely degraded and metabolized within the bloodstream.
(D) It shifts the primary target of the organophosphate from the central nervous system to the peripheral nervous system.

2011

50. Consider the following statements regarding formulation adjuvants:
I. Emulsifiers prevent the coalescence of dispersed organic droplets in water.
II. Spreaders increase the contact angle of the spray droplet on the leaf surface.
III. Stickers provide rainfastness by reducing the surface tension of the droplet.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I only
(D) III only

2018

51. The phenomenon of "hormoligosis" is an unintended consequence of chemical pest control. Which of the following defines this concept?
(A) A stimulatory effect on the reproduction of pests resulting from exposure to sub-lethal doses of an insecticide.
(B) The induction of cross-resistance to unrelated chemical groups.
(C) The rapid microbial degradation of an insecticide applied repeatedly to the same soil.
(D) The physical incompatibility of two different pesticide formulations when mixed in a spray tank.

2014

52. Which organophosphorus insecticide contains an aliphatic carbon chain and is notable for its exceptional safety margin in humans due to rapid hydrolysis by mammalian esterases?
(A) Parathion
(B) Dichlorvos
(C) Chlorpyrifos
(D) Malathion

2009

53. The active principle 'azadirachtin' derived from the neem tree belongs to which complex class of biochemical compounds?
(A) Alkaloids
(B) Limonoids (Tetranortriterpenoids)
(C) Flavonoids
(D) Isoflavonoids

2007

54. Identify the structural feature that differentiates the insecticidal carbamates from their parent compound, carbamic acid, rendering them sufficiently stable and lipophilic to penetrate insect cuticles.

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for international cooperation and showed the potential of biological methods.

152. (A) Larvae hollow out the rhizomes, destroying buoyancy and plant growth.
The biological control of the aquatic fern Salvinia molesta by the weevil Cyrtobagous salviniae was highly successful because the larvae hollow out the plant's rhizomes. This damage destroys the plant's buoyancy and its ability to grow, leading to the rapid collapse of the floating mats. This program illustrates how a highly host-specific natural enemy can provide a permanent solution.

153. (B) Mealybugs infesting diverse crops like citrus, grapes, and coffee.
The predatory ladybird beetle Cryptolaemus montrouzieri is a cornerstone of biological control in India, where it is mass-reared and released to manage various mealybug species. It has proven particularly effective in high-value crops like citrus, grapes, and coffee, providing rapid pest suppression. Often called the mealybug destroyer, both its adult and larval stages are voracious predators of soft-bodied insects.

154. (A) P-4, Q-1, R-3, S-2
Various biological control agents are successfully used in India to target specific pests. For instance, the parasitoid Epiricania melanoleuca is a vital agent for managing Pyrilla in sugarcane, while the Mexican beetle Zygogramma bicolorata is used to suppress the Parthenium weed. Trichogramma japonicum is widely released in rice fields for stem borer control, demonstrating the breadth of biological control applications.

155. (A) I, II and III
Standardized biological control in Indian sugarcane management includes the inundative release of Trichogramma chilonis and the conservation of the indigenous parasitoid Epiricania melanoleuca. Additionally, the application of the entomopathogenic fungus Metarhizium anisopliae is used to manage soil-dwelling white grubs. These practices are part of a broader integrated strategy that prioritizes natural suppression and minimizes the use of synthetic chemical insecticides.

156. (A) Both A and R are true and R is the correct explanation of A.
The introduction of the parasitoid Aphelinus mali into the apple orchards of northern India is a landmark success in classical biological control. The agent successfully established and provided permanent, self-sustaining suppression of the woolly apple aphid, which was a major threat to the industry. This case illustrates the potential for introduced natural enemies to provide long-term solutions to invasive pests.

157. (D) Goniozus nephantidis for the coconut black-headed caterpillar.
In southern India, the larval parasitoid Goniozus nephantidis is mass-released as a highly effective biological control agent against the coconut black-headed caterpillar, Opisina arenosella. This program is one of the most successful examples of augmentative biocontrol in perennial plantation crops, with the wasps being regularly produced in insectaries. This targeted approach has significantly reduced damage caused by the caterpillar.

158. (C) Complete eradication of desert locusts using imported avian predators.
While India has seen many spectacular biological control successes, the complete eradication of desert locusts using imported avian predators is not one of them. Locust management still relies heavily on monitoring and rapid chemical or microbial interventions during outbreaks. In contrast, the control of spiraling whitefly and papaya mealybug using specialized natural enemies represents well-documented and effective examples of suppression.

NODIA

159. (B) Cards should be stapled on leaf undersides in the middle canopy for protection.
When deploying tricho-cards in a cotton field, it is essential to staple them to the undersides of leaves in the middle of the canopy to protect the parasitized eggs from direct sunlight and rain. This placement also helps shield the emerging wasps from predators and extreme temperatures, ensuring a higher rate of successful emergence. Proper techniques are critical for efficacy.

160. (D) Congress grass (Parthenium hysterophorus)
The Mexican beetle, Zygogramma bicolorata, was introduced into India specifically for the biological suppression of the invasive weed Parthenium hysterophorus, or congress grass. Since 1983, it has established widely, where both larvae and adults defoliate the weed. This classical biocontrol effort significantly reduces weed growth and seed production, managing a

(D) They possess high inherent insecticidal toxicity when applied independently.

2019

8. What is the most appropriate primary function of a wetting agent when incorporated into an insecticidal foliar spray?
(A) To lower dynamic surface tension, ensuring the spray droplet spreads evenly over leaf surfaces.
(B) To increase the overall evaporation rate of the applied droplet, increasing its vapor toxicity.
(C) To function as a specialized UV-protectant, significantly slowing chemical photodegradation.
(D) To create a chemical bond between the pesticide and the plant cuticle to improve rainfastness.

2010

9. By eliminating structurally unrelated compounds, identify the organochlorine insecticide that belongs to the cyclodiene group.
(A) Lindane
(B) Endosulfan
(C) Methoxychlor
(D) Dicofol

2007

10. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Organochlorine insecticides like DDT have been globally phased out from agricultural use due to their high lipophilicity and environmental persistence.
Reason (R): High lipophilicity prevents organochlorines from crossing the insect epicuticle, rendering them highly inefficient as contact poisons.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2018

11. Which insecticide formulation consists of a solid active ingredient suspended in a liquid carrier, typically water, stabilized by dispersants?
(A) Suspension Concentrate (SC)
(B) Emulsifiable Concentrate (EC)
(C) Soluble Liquid (SL)
(D) Microencapsulation (CS)

2016

12. In the context of insecticide entry through the insect gut, the toxicity of ingested stomach poisons is heavily influenced by the gut pH. Which section of the insect alimentary canal typically exhibits a highly alkaline pH (8.0 to 10.0) in lepidopteran larvae, influencing the solubility of certain toxins?
(A) Foregut (Stomodaeum)
(B) Hindgut (Proctodaeum)
(C) Midgut (Mesenteron)
(D) Crop

2001

13. Which of the following mechanisms best explains the specific toxicity of the botanical insecticide Rotenone?
(A) Inhibition of acetylcholinesterase in the central nervous system.
(B) Disruption of the voltage-gated sodium channels leading to repetitive firing.
(C) Competitive antagonism at the GABA-gated chloride channel.
(D) Inhibition of mitochondrial electron transport at Complex I (NADH dehydrogenase).

2005

14. Which of the following statements INCORRECTLY describes the properties of synthetic pyrethroids?
(A) They exhibit a negative temperature coefficient, becoming more toxic at lower temperatures.
(B) Type II pyrethroids possess an alpha-cyano group in their chemical structure.
(C) They are highly stable in soil environments, often persisting for several years without degradation.
(D) They generally exhibit very low mammalian toxicity due to rapid enzymatic degradation in mammals.

2017

15. Consider the following statements regarding Neonicotinoid insecticides:
I. They act as agonists at the insect nicotinic acetylcholine receptors (nAChR).
II. They exhibit strong systemic properties in plants, providing protection against sap-sucking insects.
III. They are highly volatile and primarily utilized as fumigants in stored grain management.
Which of the above statement(s) is/are correct?

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2022

31. The degradation of pesticide residues in the environment often follows first-order kinetics. Based on this, the Median Residual Life (RL50) is defined as:
(A) The time required for the pesticide residue level to reach the Maximum Residue Limit (MRL).
(B) The time required for the initial pesticide concentration in the environment to be reduced by half.
(C) The safety interval between the last pesticide application and the harvesting of the crop.
(D) The acceptable daily intake of the pesticide without appreciable risk.

2016

32. In the context of pesticide food safety regulations, the Waiting Period or Pre-Harvest Interval (PHI) is scientifically established based primarily on which two factors?
(A) The toxicity color code and the formulation type.
(B) The initial deposit of the pesticide and the Acceptable Daily Intake (ADI).
(C) The LD50 of the active ingredient and the target pest species.
(D) The degradation curve of the residue and the legally established MRL.

2012

33. The QuEChERS method is universally utilized in modern residue analysis laboratories. What does the acronym QuEChERS primarily stand for in terms of its methodological advantage?
(A) Quick, Easy, Cheap, Effective, Rugged, and Safe
(B) Quantitative, Universal, Efficient, Chromatographic, High-throughput, Extraction, Resolution, System
(C) Qualitative, Extractable, Chemical, Evaluated, Rapid, and Standardized
(D) Quality, Environmental, Chromatographic, Extraction, Reliability, and Sensitivity

2011

34. When analyzing organochlorine pesticide residues at trace levels in environmental samples, which detector coupled with Gas Chromatography (GC) provides the highest sensitivity and specificity?
(A) Flame Ionization Detector (FID)
(B) Thermal Conductivity Detector (TCD)
(C) Electron Capture Detector (ECD)
(D) Flame Photometric Detector (FPD)

NODIA

2010

35. Consider the following statements regarding the international and national regulatory frameworks for pesticides:
I. The Codex Alimentarius Commission establishes international food standards and MRLs.
II. FSSAI is the apex body responsible for setting domestic MRLs for pesticides in India.
III. The Central Insecticides Board (CIB) is strictly an enforcement agency with no advisory role.
IV. HACCP protocols integrate pesticide residue monitoring to ensure food safety in processing chains.
V. The Joint FAO/WHO Meeting on Pesticide Residues (JMPR) evaluates pesticide toxicology.
Which of the above statement(s) is/are correct?
(A) I, II, III and V
(B) I, II, IV and V
(C) I, III, IV and V
(D) II, III, IV and V

2021

36. Atropine sulfate is universally administered as the primary pharmacological antidote for severe poisoning by organophosphate insecticides. What is its exact mechanism of action?
(A) It acts to chemically reactivate the phosphorylated acetylcholinesterase enzyme at the synapse.
(B) It functions by neutralizing organophosphate molecules that are circulating in the bloodstream.
(C) It prevents the release of acetylcholine from the pre-synaptic terminal into the synaptic cleft.
(D) It competitively blocks muscarinic receptors, preventing overstimulation by excessive acetylcholine.

2009

37. Which of the following is considered an INCORRECT practice during the administration of first-aid for acute pesticide poisoning?
(A) Moving the victim immediately to an open, well-ventilated area.
(B) Inducing vomiting regardless of the chemical nature of the ingested pesticide formulation.
(C) Removing contaminated clothing and washing the skin with abundant water and soap.

sodium channel that reduces its toxicant sensitivity.

2007

24. Which of the following resistance mechanisms involves a modification in the structure of the enzyme responsible for terminating nerve impulses in the cholinergic synapse?
(A) ace-1 mutation
(B) Rdl mutation
(C) Super-kdr mutation
(D) GST upregulation

2004

25. Consider the following statements regarding the Insecticide Resistance Action Committee (IRAC) classification system:
I. IRAC classifies insecticides primarily based on their biochemical mode of action rather than their chemical structure.
II. Group 1 comprises Acetylcholinesterase (AChE) inhibitors, including carbamates and organophosphates.
III. Rotating insecticides between different IRAC groups is a core strategy of Insecticide Resistance Management (IRM).
IV. Group 3 exclusively contains compounds that act as juvenile hormone analogues.
Which of the above statement(s) is/are INCORRECT?
(A) I and IV
(B) II and III
(C) I and III
(D) IV only

2022

26. Which phenomenon describes a situation where an insect population develops resistance to one insecticide, and simultaneously exhibits resistance to another insecticide it has never been exposed to, due to a shared detoxification mechanism?
(A) Multiple resistance
(B) Cross-resistance
(C) Behavioral resistance
(D) Penetration resistance

2025

27. Ecological selectivity of pesticides is a critical concept in Integrated Pest Management (IPM). Which of the following is a primary method of achieving ecological selectivity?
(A) Modifying the timing and placement of pesticide application to avoid exposing natural enemies.
(B) Utilizing an active ingredient that naturally targets specific receptors only found in the pest species.
(C) Engineering the insecticide molecule to rapidly degrade in the insect gut before reaching the hemolymph.
(D) Using genetically modified crops that express detoxification enzymes.

2015

28. Which of the following biochemical pathways is considered a Phase II metabolic reaction in the detoxification of insecticides within the insect body?
(A) Epoxidation of aldrin to dieldrin mediated by various oxidase enzymes.
(B) Hydrolysis of carboxylic ester bonds performed by specific carboxylesterases.
(C) Conjugation of toxicants with glutathione catalyzed by glutathione S-transferases.
(D) Oxidation of organophosphates by the mixed-function oxidase enzyme system.

2004

29. A significant drawback of using broad-spectrum insecticides is the destruction of natural enemies, which can lead to the sudden outbreak of a pest species that was previously of minor importance. This ecological phenomenon is known as:
(A) Pest resurgence
(B) Hormoligosis
(C) Biotype evolution
(D) Secondary pest outbreak

2015

30. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Synthetic pyrethroids belonging to Type II generally produce a distinctive poisoning syndrome in insects known as the CS (choreoathetosis with salivation) syndrome.
Reason (R): Type II pyrethroids cause rapid, repetitive discharges in the nervous system without significantly depolarizing the nerve membrane.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

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(A) I and II
(B) I and III
(C) II only
(D) III only

2022

16. What is the fundamental biochemical mechanism of action of formamidine insecticides, such as chlordimeform?
(A) Inhibition of chitin synthase during ecdysis.
(B) Blocking the release of gamma-aminobutyric acid (GABA).
(C) Uncoupling oxidative phosphorylation in the mitochondria.
(D) Mimicking the action of the neurotransmitter octopamine.

2017

17. The botanical insecticide azadirachtin is primarily classified based on its physiological effect as a:
(A) Feeding deterrent and insect growth disruptor
(B) Rapid knockdown neurotoxin
(C) Respiratory uncoupler
(D) Systemic acetylcholinesterase inhibitor

2014

18. Determine the most relevant factor contributing to the selective toxicity of malathion, which makes it relatively safe for mammals but highly toxic to insects.
(A) Insects lack the cytochrome P450 enzymes required to convert malathion into malaoxon.
(B) The mammalian acetylcholinesterase enzyme is physically structured to be immune to malaoxon.
(C) Mammalian carboxylesterases rapidly hydrolyze malathion into non-toxic carboxylic acid metabolites.
(D) Malathion is entirely unable to dissolve in or penetrate the lipid-rich membranes of mammalian skin.

2011

19. Identify the INCORRECT pair of an insecticide and its corresponding chemical group.
(A) Spinosad — Avermectin
(B) Fipronil — Phenylpyrazole
(C) Imidacloprid — Neonicotinoid
(D) Novaluron — Benzoylurea

2007

20. Match the toxicity testing parameters in List I with their correct descriptions in List II.
List I: (Toxicity testing parameters)
P. LD50
Q. KD50
R. LT50
S. ED50
List II: (Descriptions)
1. Time required to kill half of the test population at a specific dose.
2. Dose producing a specific measurable, non-lethal biological effect in half the population.
3. Dose required to paralyze or immobilize half of the test population.
4. Dose required to cause mortality in half of the test population.
(A) P-4, Q-3, R-1, S-2
(B) P-4, Q-1, R-3, S-2
(C) P-3, Q-4, R-2, S-1
(D) P-1, Q-2, R-4, S-3

2001

21. Which method is most appropriate for evaluating the statistical joint action of two insecticides to determine whether their combined effect is synergistic, antagonistic, or simply additive?
(A) Calculating the Median Residual Life (RL50) of both chemicals in the soil.
(B) Deriving the Co-toxicity Coefficient (Sun and Johnson method).
(C) Measuring the Maximum Residue Limit (MRL) for each chemical in the crop.
(D) Performing a standard QuEChERS extraction to quantify the total residues.

NODIA

2011

22. In probit analysis, the fundamental transformation converts the sigmoidal dose-response curve into a linear relationship. This is achieved by plotting the probit of percentage mortality against the:
(A) Square root of the time of exposure
(B) Inverse of the application rate
(C) Logarithm of the dosage
(D) Exponential of the temperature

2004

23. What specific physiological change characterizes the 'kdr' (knockdown resistance) mechanism observed in various insect pests against DDT and pyrethroids?
(A) Metabolic amplification of carboxylesterase genes leading to rapid enzymatic degradation.
(B) Over-expression of cytochrome P450 monooxygenases that detoxify the insecticide.
(C) Significant alteration in the cuticular thickness or composition that prevents penetration.
(D) A point mutation in the voltage-gated

(D) Keeping the patient warm and in a resting position while awaiting medical help.

2017

38. Under the provisions of the Insecticides Act, 1968, in India, which specific statutory body is legally empowered to scrutinize the bio-efficacy and safety data of a pesticide to grant its formal registration?
(A) Central Insecticides Laboratory (CIL)
(B) Indian Council of Agricultural Research (ICAR)
(C) Registration Committee (RC)
(D) Directorate of Plant Protection, Quarantine & Storage (DPPQS)

2012

39. The Pesticide Management Bill (PMB) of 2020 was introduced to replace the legacy Insecticides Act of 1968. Which of the following represents a significant proposed reform in the PMB 2020?
(A) It mandates the complete deregistration of all biological and botanical pesticides.
(B) It eliminates the requirement for Maximum Residue Limits (MRL) for export-oriented agricultural commodities.
(C) It transfers the authority of pesticide registration from the central government to individual state governments.
(D) It introduces a provision to compensate farmers in cases of crop loss caused by sub-standard or spurious pesticides.

2006

40. Match the neuroactive insecticides in List I with their precise target sites in List II.
List I: (Neuroactive insecticides)
P. DDT
Q. Endosulfan
R. Cartap hydrochloride
S. Indoxacarb
List II: (Target sites)
1. Voltage-gated sodium channel blocker
2. Voltage-gated sodium channel modulator (prolongs opening)
3. Nicotinic acetylcholine receptor (nAChR) channel blocker
4. GABA-gated chloride channel antagonist
(A) P-2, Q-4, R-3, S-1
(B) P-1, Q-4, R-3, S-2
(C) P-2, Q-3, R-4, S-1
(D) P-1, Q-2, R-4, S-3

2001

41. Which class of insecticides is known to uncouple oxidative phosphorylation, disrupting the proton gradient across the inner mitochondrial membrane and halting ATP production?
(A) Benzoylureas (e.g., Diflubenzuron)
(B) Pyrroles (e.g., Chlorfenapyr)
(C) Pyrethroids (e.g., Deltamethrin)
(D) Carbamates (e.g., Carbaryl)

2006

42. Among the following insect growth regulators (IGRs), which compound functions specifically as an ecdysone receptor agonist, inducing a premature, lethal molt in lepidopteran larvae?
(A) Methoprene
(B) Tebufenozide
(C) Lufenuron
(D) Pyriproxyfen

2013

43. Which biochemical parameter determines the phase distribution of an applied insecticide between the hydrophilic environment of the hemolymph and the lipophilic insect cuticle?
(A) Octanol-water partition coefficient ($K_{\{ow\}}$)
(B) Michaelis constant (K_m)
(C) Median lethal dose ($LD_{\{50\}}$)
(D) Specific gravity

2019

44. An insecticide is applied to a pest population, but its efficacy drops drastically when the ambient temperature rises from 25°C to 35°C. This phenomenon is characteristic of which group of chemicals?
(A) Organophosphates
(B) Neonicotinoids
(C) Synthetic Pyrethroids
(D) Avermectins

2009

45. Consider the following synthetic pyrethroids:
I. Fenvalerate / Deltamethrin
II. Allethrin
III. Resmethrin / Bioresmethrin
IV. Tefluthrin / Bifenthrin
What is the correct chronological order of their evolutionary generations from earliest to most recently developed?
(A) II, I, III, IV
(B) II, III, I, IV
(C) III, II, I, IV
(D) II, III, IV, I

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CHAPTER 06
Chemical Control and Toxicology

2006

1. Which of the following compounds is recognized as the first widely successful systemic organic insecticide, pioneering the development of the organophosphate group?
(A) Schradan
(B) Paris green
(C) Dichlorodiphenyltrichloroethane
(D) Lead arsenate

2007

2. The chronological evolution of insecticides is categorized into distinct generations. Which of the following correctly identifies a 'Third Generation' insecticide?
(A) Organochlorine compounds
(B) Macrocyclic avermectins
(C) Juvenile hormone analogues
(D) Inorganic arsenical salts

2025

3. In the standard toxicity color-coding of pesticide formulations in India, which signal word and color triangle correspond to an extremely toxic pesticide with an oral LD50 of less than 50 mg/kg?
(A) POISON (Red)
(B) DANGER (Yellow)
(C) WARNING (Blue)
(D) CAUTION (Green)

2024

4. Identify the correct statement regarding the physical properties of emulsifiable concentrates (EC).
(A) They consist of solid active ingredients dispersed in an aqueous medium with wetting agents.
(B) They require continuous high-speed mechanical agitation to prevent active ingredient settling.
(C) They inherently decrease the rate of cuticular penetration relative to dry wettable powders.
(D) They are non-aqueous liquid formulations with active ingredient, hydrophobic solvent, and emulsifier.

NODIA

2014

5. Choose the correct sequence of phases involved in the cuticular penetration of an externally applied contact insecticide.
(A) Partitioning into the epicuticular wax → Diffusion through the procuticle → Transport via hemolymph → Target site binding
(B) Transport via hemolymph → Partitioning into epicuticular wax → Diffusion through procuticle → Target site binding
(C) Diffusion through the procuticle → Partitioning into epicuticular wax → Target site binding → Transport via hemolymph
(D) Target site binding → Diffusion through the procuticle → Partitioning into epicuticular wax → Transport via hemolymph

2009

6. The substitution of legacy Wettable Powder (WP) formulations with Water Dispersible Granules (WDG) is primarily driven by which of the following causes?
(A) WDGs provide significantly enhanced vapor action and fumigant toxicity compared to older WP products.
(B) WDGs allow for the complete removal of all external surfactants and dispersing agents in the mix.
(C) WDGs minimize inhalation hazards during handling by being virtually dust-free.
(D) WDGs demonstrate high solubility in non-polar organic solvents which is not characteristic of WPs.

2018

7. Which of the following is NOT a functional characteristic of pesticide synergists such as Piperonyl Butoxide (PBO)?
(A) They function by competitively inhibiting cytochrome P450 monooxygenases.
(B) They significantly enhance the lethality of pyrethroids by preventing their rapid metabolic degradation.
(C) They are often formulated with natural pyrethrins to reduce the required dose of the active ingredient.

(A) The addition of a heavy metal atom like arsenic or lead to the central core of the chemical structure.
(B) The complete removal of the double-bonded carbonyl oxygen from the center of the carbamic acid chain.
(C) Substitution at the nitrogen atom and esterification of the carboxyl group with specific organic moieties.
(D) Halogenation of the central nitrogen atom with reactive elements such as chlorine, bromine, or fluorine.

2013

55. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Chitin synthesis inhibitors (CSIs) such as diflubenzuron are highly effective against the adult stages of holometabolous insects.
Reason (R): CSIs completely disrupt the formation of the new procuticle, a process that occurs continuously in adult insects during reproduction.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2016

56. Diamide insecticides (e.g., chlorantraniliprole) represent a breakthrough in specific pest control. What is their exact molecular target?
(A) Ryanodine receptors (calcium channels)
(B) Octopamine receptors
(C) Ecdysone receptors
(D) Acetylcholinesterase

2009

57. Which phase of insecticide metabolism involves primary reactions such as oxidation, reduction, and hydrolysis, thereby introducing reactive functional groups into the toxicant molecule?
(A) Phase II metabolism
(B) Phase I metabolism
(C) Phase III metabolism
(D) Bioactivation phase

2010

58. Some insecticides are formulated as pro-insecticides that must be biologically converted into their active toxic form within the insect body. Which of the following is a classic example of such bioactivation?
(A) Conversion of DDT to DDE.
(B) Conversion of malathion to malaoxon.
(C) Conjugation of parathion with glutathione.
(D) Hydrolysis of carbaryl to 1-naphthol.

2022

59. The development of 'super-kdr' resistance in houseflies and other insects provides extremely high levels of resistance to pyrethroids. This is typically caused by:
(A) A secondary mutation (such as M918T) occurring in tandem with the primary kdr mutation in the sodium channel.
(B) A single point mutation at the L1014F locus in the voltage-gated sodium channel that provides moderate resistance.
(C) Massive overproduction of specific carboxylesterase enzymes that sequester pyrethroids in the hemolymph.
(D) Significant thickening of the external cuticular wax layer which blocks the penetration of applied chemicals.

2006

60. Consider the following statements regarding environmental dynamics and pesticide residues:
I. Photodegradation occurs solely in the soil matrix where UV light cannot penetrate.
II. A longer half-life indicates a lower environmental persistence of the pesticide.
III. Leaching potential is positively correlated with high water solubility and low soil adsorption.
IV. Acceptable Daily Intake (ADI) is expressed in milligrams of pesticide per kilogram of crop yield.
Which of the above statement(s) is/are INCORRECT?
(A) I, II and IV
(B) I and III
(C) II and IV
(D) I, III and IV

NODIA

2013

61. In the context of risk assessment, what is the 'No Observed Adverse Effect Level' (NOAEL)?
(A) The minimum concentration required to cause a measurable 1% mortality rate in a specific pest population.
(B) The legal threshold for the concentration of pesticide residue allowed on a harvested agricultural food commodity.
(C) The maximum acceptable concentration of

2011

75. Choose the correct sequence of regulatory steps required to introduce a newly discovered pesticide molecule into the Indian market.
(A) Field bio-efficacy trials → Submission of dossier to Registration Committee (RC) → Scrutiny by experts → Issuance of Certificate of Registration under Section 9
(B) Issuance of Certificate → Field bio-efficacy trials → Scrutiny by RC → Submission of dossier
(C) Submission of dossier → Field bio-efficacy trials → Issuance of Certificate → Scrutiny by RC
(D) Scrutiny by RC → Issuance of Certificate → Submission of dossier → Field bio-efficacy trials

2024

76. Certain pesticides are designated as "Restricted Use Pesticides" (RUPs) by regulatory authorities. What does this classification imply?
(A) The pesticide is legally restricted and can only be used on non-food crops like industrial cotton and timber.
(B) The pesticide is banned entirely by the government and cannot be legally manufactured, sold, or imported.
(C) Hazard concerns mean these can only be purchased and applied by certified, trained applicators.
(D) The pesticide is environmentally restricted to application during the winter season to protect local wildlife.

2017

77. In the calculation of the Co-toxicity Coefficient, a value significantly greater than 100 indicates which type of joint action between two insecticides?
(A) Additive action
(B) Independent action
(C) Antagonism
(D) Synergism

2025

78. Which of the following is a physical property characteristic of 'Dust' formulations?
(A) They are designed to be highly soluble in water for application through large-scale sprinkler irrigation systems.
(B) They exhibit extreme rainfastness and will tightly bind to the plant surfaces immediately upon physical contact.
(C) They possess particle sizes from 10 to 50 micrometers and low concentrations (1-5%) of active ingredient.
(D) They consist of specialized microcapsules that slowly release the active ingredient over a long period of time.

2014

79. The term 'LD50' is widely used in toxicology. However, when assessing the acute inhalation toxicity or the toxicity of chemicals in aquatic environments, which parameter is technically more appropriate?
(A) ED50 (Median Effective Dose)
(B) LC50 (Median Lethal Concentration)
(C) KD50 (Median Knockdown Dose)
(D) LT50 (Median Lethal Time)

2016

80. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Organophosphate insecticides are generally characterized by relatively low environmental persistence compared to organochlorines.
Reason (R): Organophosphates contain ester linkages that are highly susceptible to hydrolysis by moisture and degradation by soil microbes.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2014

81. Identify the INCORRECT statement regarding the bioassay of insecticides.
(A) A bioassay strictly determines the chemical structure of the unknown toxic compound.
(B) Bioassays measure the biological response of a living organism to a specific concentration of a toxicant.
(C) Potter's Tower is a standard apparatus used to achieve uniform precision spraying in laboratory bioassays.
(D) Control groups treated only with the solvent are mandatory to calculate corrected mortality.

2018

82. In correcting bioassay mortality data for natural control mortality, Abbott's formula is universally applied. What is the mathematical expression of Abbott's formula?

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2008

69. High-Performance Liquid Chromatography (HPLC) coupled with Mass Spectrometry (LC-MS/MS) is heavily relied upon in modern pesticide residue analysis. What is its primary advantage over traditional Gas Chromatography (GC)?

(A) LC-MS/MS requires significantly larger analytical sample sizes, ensuring better homogenization of the matrix.
(B) It allows analysis of thermally unstable, polar, and non-volatile pesticides without needing derivatization.
(C) LC-MS/MS operates at higher temperatures, completely vaporizing all compounds including thermolabile ones.
(D) LC-MS/MS completely eliminates the medical need for any extraction or clean-up steps like the QuEChERS method.

2023

70. Consider the following statements regarding the Insecticides Act, 1968:

I. Section 9 of the Act strictly deals with the registration of insecticides in India.
II. The Central Insecticides Board (CIB) is composed of approximately 30 members, including agricultural and medical experts.
III. State governments hold the primary authority to grant original registration certificates for new active ingredients.
IV. Insecticide Inspectors are legally empowered to take samples and stop the sale of misbranded insecticides.
V. Section 27 outlines the power to prohibit sale for reasons of public safety.

Which of the above statement(s) is/are INCORRECT?

(A) I, III and V
(B) II, IV and V
(C) III and V
(D) II and III

2006

71. What is the fundamental principle defining a "biorational" insecticide within an Integrated Pest Management (IPM) framework?

(A) It is designed to be universally lethal to all biological organisms, ensuring the total eradication of every pest.
(B) It consists exclusively of raw, unprocessed, and live microbial agents that act directly on the target host.
(C) It degrades into completely harmless components within 24 hours of application regardless of the environment.
(D) It targets biological processes specific to pests, showing minimal toxicity to humans and non-target species.

2003

72. Which specific enzyme class is frequently implicated in the metabolic resistance of insect pests to synthetic pyrethroids and organophosphates through enhanced oxidative detoxification?

(A) Cytochrome P450 monooxygenases
(B) Hexokinases
(C) Acetylcholinesterases
(D) Chitin synthases

2025

73. Which of the following symptoms is characteristically associated with acute organophosphate poisoning in mammals, governed by the acronym SLUDGE?

(A) Tachycardia, mydriasis, and severe dryness of the mouth accompanied by decreased gastrointestinal motility.
(B) Salivation, lacrimation, urination, defecation, GI motility, and emesis (SLUDGE).
(C) Complete muscular flaccidity of the extremities followed immediately by a state of deep, irreversible coma.
(D) Severe cutaneous allergic reactions and epidermal necrolysis spanning the majority of the body's surface area.

NODIA

2025

74. While Atropine addresses the muscarinic symptoms of organophosphate poisoning, Oximes (such as Pralidoxime/PAM) are administered to address the nicotinic symptoms. How do Oximes function biochemically?

(A) They act by rapidly lowering the patient's core body temperature to slow down the overall rate of intoxication.
(B) They nucleophilically attack the OP-enzyme complex, releasing the organophosphate and reactivating the enzyme.
(C) They bind to and block the nicotinic acetylcholine receptors to prevent stimulation in the central nervous system.
(D) They induce the rapid enzymatic synthesis of entirely new acetylcholinesterase molecules within the liver.

an insecticide found in surface water within a protected environment.
(D) The highest experimental dose that produces no statistically significant adverse effects in animal toxicity studies.

2009

62. Which physiological barrier in the insect gut must ingested insecticides cross to reach the hemolymph and subsequently their target sites?
(A) The epicuticular wax layer
(B) The spiracular atrium
(C) The peritrophic matrix and midgut epithelium
(D) The Malpighian tubules

2009

63. Choose the specific biochemical role of glutathione S-transferases (GSTs) in insect detoxification mechanisms.
(A) They oxidize aromatic rings of the pesticide molecule using molecular oxygen through the oxidase system.
(B) They catalyze the conjugation of toxicants with glutathione, making them more water-soluble for easier excretion.
(C) They split ester bonds found in organophosphates and synthetic pyrethroids using specialized esterase enzymes.
(D) They work to specifically reverse the binding of organophosphate molecules from the acetylcholinesterase site.

2010

64. A major principle of Insecticide Resistance Management (IRM) is the 'high-dose/refuge' strategy, widely utilized with Bt crops. What is the primary purpose of the refuge in this strategy?
(A) To provide a concentrated breeding ground for natural enemies to effectively control emerging resistant pests.
(B) To act as a specialized trap crop that absorbs and neutralizes excess pesticide residues from the surrounding area.
(C) To ensure efficient cross-pollination between plants to enhance the overall vigor and yield of the treated Bt crop.
(D) To maintain susceptible insects that mate with resistant ones, diluting resistance alleles in the population.

2023

65. Match the botanical insecticides in List I with their corresponding active principles in List II.

List I: (Botanical insecticides)
P. Neem
Q. Tobacco
R. Pyrethrum flowers
S. Derris roots

List II: (Active principles)
1. Cinerin I and II, Jasmolin I and II
2. Azadirachtin, Salannin, Nimbin
3. Rotenone, Deguelin
4. Nicotine, Nornicotine

(A) P-2, Q-4, R-1, S-3
(B) P-1, Q-4, R-2, S-3
(C) P-2, Q-1, R-4, S-3
(D) P-4, Q-2, R-1, S-3

2025

66. Fumigants are primarily utilized for the control of storage pests and soil nematodes. By which anatomical route do fumigants typically enter the insect body?
(A) Through active ingestion via the mouthparts.
(B) Direct diffusion through the sclerotized procuticle.
(C) Through the spiracles and into the tracheal system during respiration.
(D) Via absorption through the sensory sensilla on the antennae.

2022

67. The phenomenon of "accelerated microbial degradation" often affects the efficacy of soil-applied pesticides. This occurs when:
(A) Repeated applications enrich soil microbes that rapidly metabolize the pesticide as a carbon source.
(B) The pesticide chemically reacts with soil minerals, forming complex insoluble molecules that cannot be used.
(C) Soil pH levels shift dramatically, causing the spontaneous chemical hydrolysis of the active ingredient.
(D) Ultraviolet light physically breaks down the pesticide molecules that are present on the surface of the soil.

2012

68. Which parameter establishes the maximum legally permissible concentration of a pesticide residue in or on food and agricultural commodities at the time of trade?
(A) Median Lethal Dose (LD50)
(B) Acceptable Daily Intake (ADI)
(C) Maximum Tolerated Dose (MTD)
(D) Maximum Residue Limit (MRL)

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(A) $\text{Corrected\%} = \left[\frac{\%\text{Test Mortality} - \%\text{Control Mortality}}{100 - \%\text{Control Mortality}}\right] \times 100$

(B) $\text{Corrected\%} = \left[\frac{\%\text{Test Mortality} + \%\text{Control Mortality}}{100}\right] \times 100$

(C) $\text{Corrected\%} = \left[\frac{100 - \%\text{Test Mortality}}{\%\text{Control Mortality}}\right] \times 100$

(D) $\text{Corrected\%} = \left[\frac{\%\text{Control Mortality} - \%\text{Test Mortality}}{100}\right] \times 100$

2025

83. Which modern formulation technology relies heavily on interfacial polymerization to entrap the active ingredient within a polymeric shell, allowing for controlled or delayed release?
(A) Microencapsulated Suspensions (CS)
(B) Suspension Concentrates (SC)
(C) Water Dispersible Granules (WDG)
(D) Emulsifiable Concentrates (EC)

2004

84. Which insecticidal chemical group is structurally modeled after the natural compound nereistoxin, isolated from marine annelid worms?
(A) Spinosyns
(B) Neonicotinoids
(C) Diamides
(D) Nereistoxin analogues (e.g., Cartap, Thiocyclam)

2016

85. Consider the following statements regarding the action of GABA-gated chloride channel antagonists:
I. They include fipronil and the legacy cyclodienes.
II. They bind to the chloride channel and lock it in the open position, causing hyperpolarization.
III. By blocking the inhibitory action of GABA, they cause hyperexcitation and convulsions in insects.
Which of the above statement(s) is/are correct?
(A) I and II
(B) I and III
(C) II only
(D) III only

2010

86. How does the systemic insecticide Pymetrozine (a pyridine azomethine) specifically control aphid populations?
(A) It disrupts their molting process by inhibiting chitin synthase during the transition between life stages.
(B) It acts as a contact poison that rapidly dissolves the protective aphid epicuticle upon physical exposure.
(C) It causes an irreversible block of the salivary pump and stylet function, causing death by starvation.
(D) It functions primarily as a powerful ecdysone antagonist that prevents normal insect development.

2015

87. Spirotetramat is a unique systemic insecticide known for its two-way systemicity. What does this mean in an agricultural application context?
(A) It can act simultaneously as an organophosphate and a carbamate to overcome target-site resistance.
(B) It kills insects upon initial contact and also operates as a gaseous fumigant within the soil matrix.
(C) It protects both the treated plant and any immediately adjacent untreated plants through vapor transfer.
(D) It is translocated via the xylem and phloem, protecting new shoots and roots throughout the plant.

2009

88. According to the IRAC MoA classification, which of the following is considered an inhibitor of acetyl-CoA carboxylase, primarily affecting lipid synthesis in insects?
(A) Tetronic and tetramic acid derivatives, such as Spiromesifen or Spirotetramat.
(B) Benzoylureas which inhibit chitin synthesis, such as Diflubenzuron or Lufenuron.
(C) Avermectins which activate chloride channels, such as Abamectin or Emamectin benzoate.
(D) Oxadiazines which block sodium channels, such as Indoxacarb or related chemical compounds.

NODIA

2010

89. Which pair of terms correctly describes the differing physiological action of pyrethroids versus avermectins on insect nervous systems?
(A) Pyrethroids work by inhibiting acetylcholinesterase; avermectins function by stimulating this specific enzyme.
(B) Pyrethroids modulate sodium channels (depolarization); avermectins activate chloride channels (hyperpolarization).
(C) Pyrethroids block GABA receptors; avermectins block nicotinic acetylcholine receptors in the central nervous system.

(A) A single population evolves resistance to an insecticide, which then protects it from a chemically unrelated one.
(B) An insect requires multiple, high-dose applications of the same insecticide to achieve a significant mortality rate.
(C) A single population has multiple independent mechanisms, allowing survival against several insecticide classes.
(D) An insect population naturally avoids the treated area by utilizing multiple alternative host plants in the area.

2007

119. The effectiveness of soil-applied granular insecticides is strongly dependent on soil moisture. Why is adequate soil moisture critical for granular formulations?
(A) Moisture chemically breaks down the sand or clay core of the granule, destroying the formulation completely.
(B) Dry soils cause the granules to immediately volatilize into the atmosphere as a highly toxic concentrated gas.
(C) Granules physically repel water, creating dry pockets in the soil where pest insects cannot survive for long.
(D) Moisture facilitates desorption and release of the active ingredient from the carrier into the soil.

2017

120. Which of the following is NOT a recognized strategy within an Insecticide Resistance Management (IRM) program?
(A) Applying sublethal doses of insecticides to gradually acclimatize the pest population.
(B) Utilizing sequential applications or rotations of insecticides with different IRAC Mode of Action classifications.
(C) Integrating cultural and biological control methods to reduce reliance on chemical insecticides.
(D) Utilizing tank mixtures of distinct active ingredients, provided they exhibit different modes of action and lack cross-resistance.

2001

121. The toxicity of an insecticide is fundamentally dose-dependent. In constructing a typical dose-response curve, the relationship between mortality (Y-axis) and dose (X-axis) typically takes which geometric shape before probit transformation?
(A) Linear
(B) Sigmoidal (S-shaped)
(C) Exponential
(D) Parabolic

2025

122. Under the Hazard Analysis and Critical Control Point (HACCP) system in food production, pesticide application and residue monitoring are typically managed as:
(A) A critical limit (CL) that cannot be altered or adjusted during the standard food production cycle.
(B) A Prerequisite Program (PRP) or Chemical CCP used to ensure residues do not exceed legal MRLs.
(C) A physical hazard that is strictly monitored only at the final packaging stage of the food product.
(D) An aesthetic quality standard that is completely unrelated to the actual chemical safety of the food.

2011

123. Which of the following statements INACCURATELY describes the function of synergists?
(A) They increase the penetrability of the toxicant through the cuticle by acting as organic solvents.
(B) They are chemical compounds that lack any significant inherent toxicity at the standard applied doses.
(C) They are widely mixed with synthetic pyrethroids to counteract metabolic resistance mechanisms in insects.
(D) They primarily function by binding to and inhibiting detoxification enzymes such as mixed-function oxidases.

2006

124. Cytochrome P450 enzymes are heme-thiolate proteins. What is the fundamental requirement for their catalytic cycle when oxidizing a pesticide substrate?
(A) Adenosine triphosphate (ATP) and inorganic phosphate molecules.
(B) Acetyl-CoA and water molecules used in conjugation reactions.
(C) Molecular oxygen and a reducing agent (typically NADPH).
(D) Reduced glutathione and carbon dioxide produced during metabolism.

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vascular system.
(B) To permit the complete elimination of all natural enemies from the treated field before harvesting begins.
(C) To give the applied pesticide enough time to physically evaporate completely into the surrounding atmosphere.
(D) To ensure residues degrade below legal ADI and MRL limits before the crop is consumed by humans.

2009

97. Which of the following is considered the most common resistance mechanism evolved by Helicoverpa armigera against synthetic pyrethroids?
(A) Over-expression of cytochrome P450 monooxygenases leading to rapid metabolic detoxification.
(B) Complete morphological loss of the insect cuticle.
(C) Behavioral avoidance of treated crop surfaces via modified flight patterns.
(D) Enhanced excretion of the intact pyrethroid molecule via the Malpighian tubules without metabolism.

2013

98. In the probit transformation utilized in insecticide bioassays, a 50% mortality rate corresponds precisely to which probit value?
(A) 0
(B) 2.5
(C) 5.0
(D) 10.0

2021

99. The "Food Safety and Standards Authority of India" (FSSAI) operates under which parent legislation?
(A) The Food Safety and Standards Act, 2006
(B) The Insecticides Act, 1968
(C) The Environment (Protection) Act, 1986
(D) The Essential Commodities Act, 1955

2019

100. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Glutathione S-transferases (GSTs) are critical Phase II detoxification enzymes involved in the metabolism of several insecticide classes.
Reason (R): GSTs achieve detoxification by converting highly polar pesticide metabolites into strongly lipophilic compounds that are easily stored in the insect fat body.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

NODIA

2022

101. Which specific insecticide is famously known for undergoing biomagnification, leading to the thinning of eggshells in apex predatory birds due to interference with calcium deposition?
(A) Carbofuran
(B) DDT (and its metabolite DDE)
(C) Imidacloprid
(D) Malathion

2001

102. What differentiates 'acute toxicity' from 'chronic toxicity' in the context of pesticide exposure?
(A) Acute toxicity involves low-level exposure over a long period, while chronic toxicity involves a single high dose.
(B) Acute toxicity manifests within 24 hours of exposure; chronic toxicity arises from repeated exposure over time.
(C) Acute toxicity is strictly limited to oral ingestion, whereas chronic toxicity refers only to dermal absorption.
(D) There is no functional difference; both terms are legally and scientifically synonymous under current laws.

2009

103. Which metabolic reaction is defined as the cleavage of an ester or amide linkage by the addition of a water molecule, typically catalyzed by esterases?
(A) Epoxidation
(B) Conjugation
(C) Reduction
(D) Hydrolysis

2019

104. Which of the following is a primary characteristic of a 'Soluble Liquid' (SL) formulation?
(A) The active ingredient dissolves in water, forming a true, clear solution that requires no agitation.
(B) It contains microscopic capsules that slowly degrade to release the active ingredient over a period of time.
(C) It forms a cloudy, milky emulsion when

(D) Pyrethroids uncouple oxidative phosphorylation; avermectins inhibit Complex I of the electron transport chain.

2006

90. Match the analytical techniques in List I with their primary application in pesticide residue analysis in List II.

List I: (Analytical techniques)

P. Gas Chromatography (GC)

Q. Mass Spectrometry (MS)

R. QuEChERS

S. Rotary Evaporator

List II: (Primary applications)

1. Concentration of liquid extracts by removing solvents under vacuum.
2. Separation of volatile and semi-volatile pesticide compounds.
3. Identification and precise structural confirmation of molecular fragments.
4. Rapid sample preparation, extraction, and clean-up.

(A) P-2, Q-3, R-4, S-1

(B) P-3, Q-2, R-4, S-1

(C) P-2, Q-4, R-3, S-1

(D) P-1, Q-3, R-2, S-4

2017

91. When applying the principles of Integrated Pest Management (IPM), which insecticide is considered relatively safe for pollinating bees when applied appropriately due to its specific physiological selectivity and short residual contact toxicity?

(A) Phosalone

(B) Deltamethrin

(C) Dimethoate

(D) Carbofuran

2015

92. Identify the INCORRECT statement regarding the toxicity and metabolism of the botanical insecticide nicotine.

(A) Nicotine acts as a potent agonist at the nicotinic acetylcholine receptors in both insects and mammals.

(B) It is highly toxic when absorbed through the skin, representing a severe handling hazard.

(C) It is chemically stable and persists in the environment for decades without degrading.

(D) In commercial formulations, it was historically applied as nicotine sulfate.

2018

93. A primary limitation of using botanical extracts like neem and pyrethrum in modern agriculture is their:

(A) High persistence leading to biomagnification in the food chain.

(B) Inability to be degraded by environmental microbes.

(C) Tendency to induce extreme, uncontrollable pest resurgence immediately after application.

(D) Rapid degradation upon exposure to ultraviolet (UV) light and elevated temperatures.

2004

94. The term 'bioaccumulation' refers specifically to which ecological process?

(A) The gradual increase in the concentration of a chemical across successive trophic levels of a local food web.

(B) The rapid degradation of a chemical by soil bacteria in a concentrated area due to microbial enrichment.

(C) Buildup of a toxicant within an organism faster than it can be excreted or metabolized.

(D) The physical accumulation of pesticide dust or granules on the external surfaces of protected plant leaves.

2018

95. Consider the following statements regarding Insect Growth Regulators (IGRs):

I. They are highly toxic to adult insects, causing immediate knockdown.

II. Juvenile Hormone analogues prevent the insect from developing into a mature adult.

III. They are generally considered safe for vertebrates due to the lack of target sites like chitin in mammals.

IV. They are highly effective when applied as fumigants for stored grain protection.

Which of the above statement(s) is/are INCORRECT?

(A) I and II

(B) I and IV

(C) II and III

(D) III and IV

2006

96. What is the fundamental principle behind the "waiting period" (PHI) established for agricultural crops treated with pesticides?

(A) To allow sufficient time for the plant to absorb the pesticide entirely into the internal

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called Organophosphate-Induced Delayed Polyneuropathy (OPIDN). What is the specific molecular target responsible for this secondary pathogenesis?
(A) Acetylcholinesterase (AChE)
(B) Neuropathy Target Esterase (NTE)
(C) Voltage-gated calcium channels
(D) Cytochrome c oxidase

2014

112. The botanical extract Pyrethrum consists of six active esters. Which acid and alcohol components combine to form the most potent insecticidal ester, Pyrethrin I?
(A) Pyrethric acid and Cinerolone
(B) Chrysanthemic acid and Jasmolone
(C) Pyrethric acid and Pyrethrolone
(D) Chrysanthemic acid and Pyrethrolone

2022

113. In the classification of pesticides by their hazard criteria, the LD50 values for dermal toxicity are typically:
(A) Higher than oral LD50 values, as the dermal barrier significantly restricts chemical absorption.
(B) Significantly lower than oral LD50 values for the same chemical tested on the same species.
(C) Completely identical to oral LD50 values for the same chemical regardless of the formulation.
(D) Statistically irrelevant and not calculated for the registration of modern pesticide formulations.

2012

114. How does the insecticidal compound Spinosad, derived from the actinomycete Saccharopolyspora spinosa, manifest its toxicity?
(A) It is a competitive antagonist of the ecdysone receptor that prevents normal insect molting processes.
(B) It blocks the voltage-gated sodium channels in the insect axon, preventing the transmission of nerve impulses.
(C) It activates nAChRs via an allosteric site distinctly different from the neonicotinoid binding site.
(D) It functions as a powerful juvenile hormone mimic that prevents larvae from developing into mature adults.

2013

115. Consider the following events in the evolution of insecticide resistance:
I. Survival and reproduction of resistant individuals.
II. Rare genetic mutations or pre-existing resistant alleles are present in the population at low frequencies.
III. Application of the insecticide eliminates the vast majority of susceptible individuals.
IV. The frequency of the resistant allele increases significantly in subsequent generations, leading to field control failure.
What is the correct logical sequence of these events under continuous chemical selection pressure?
(A) II, III, I, IV
(B) III, II, I, IV
(C) II, I, III, IV
(D) I, III, II, IV

2003

116. Which specific molecular mechanism confers 'target-site insensitivity' to cyclodiene insecticides and fipronil in resistant insects?
(A) The 'ace-1' point mutation in the acetylcholinesterase gene which is characteristic of OP resistance.
(B) The 'kdr' mutation in the sodium channel gene which is commonly found in pyrethroid-resistant insects.
(C) The massive amplification of esterase genes that leads to the rapid metabolic breakdown of the toxicant.
(D) The 'Rdl' mutation in the GABA-gated chloride channel subunit gene that reduces ligand binding.

2008

117. An insecticide is characterized as having a highly positive temperature coefficient. What does this indicate about its biological efficacy?
(A) Its toxicity to the target insect increases as the ambient temperature decreases.
(B) Its toxicity to the target insect increases as the ambient temperature increases.
(C) Its toxicity is completely unaffected by temperature fluctuations.
(D) Its half-life in the environment increases proportionally with temperature.

2013

118. Which statement provides the most accurate definition of 'Multiple Resistance' in insect populations?

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mixed with water due to the presence of specialized emulsifiers.
(D) It is specifically designed to be applied without any dilution, directly as a dry dust on the target area.

2011

105. Consider the following statements regarding pesticide legislation in India:
I. The Central Insecticides Board (CIB) advises the government on technical matters related to insecticide risks.
II. Registration of pesticides is strictly mandatory before import, manufacture, or sale.
III. The 'Precautionary Principle' is integrated into modern Indian pesticide regulations.
IV. Banned pesticides can still be legally exported to other countries under specific regulatory provisions if permitted by the importing nation.
V. Section 29 of the Insecticides Act covers offenses and corresponding penalties.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, II, IV and V
(C) II, III and V
(D) I, IV and V

2017

106. In toxicokinetics, the 'partition coefficient' of an insecticide typically references its solubility ratio between which two standard phases?
(A) Hexane and Chloroform
(B) 1-Octanol and Water
(C) Ethanol and Lipids
(D) Benzene and Hemolymph

2003

107. Which of the following best defines 'Codex Alimentarius'?
(A) International food standards and guidelines to protect consumer health and ensure fair trade.
(B) A comprehensive list of internationally banned pesticides managed and updated by the World Health Organization.
(C) A specific analytical chemistry technique used to detect trace organochlorines in environmental samples.
(D) The biological classification index for beneficial insect predators used in integrated pest management.

2012

108. An agricultural worker accidentally inhales a large dose of a fumigant. Which physiological barrier is bypassed completely by this route of entry, accelerating the onset of toxic symptoms?
(A) The central nervous system blood-brain barrier.
(B) The alveolar-capillary membrane.
(C) The hepatic (liver) first-pass metabolism system.
(D) The gastrointestinal tract mucosa and cuticular barriers.

2023

109. What is the fundamental concept underlying the calculation of the Acceptable Daily Intake (ADI)?
(A) It is the exact dose of a pesticide that will cause a measurable 5% mortality rate in a test population.
(B) It is the absolute maximum amount of active ingredient allowed to be sprayed per hectare on any given day.
(C) It is the strictly required interval between the final application of a pesticide and the start of the harvest.
(D) Estimated amount of pesticide in food/water ingested daily over a lifetime without appreciable health risk.

NODIA

2021

110. Match the resistance mechanisms in List I with their defining characteristics in List II.
List I: (Resistance mechanisms)
P. Metabolic Resistance
Q. Target-site Resistance
R. Penetration Resistance
S. Behavioral Resistance
List II: (Defining characteristics)
1. Alteration in the thickness or lipid composition of the insect cuticle.
2. An insect detects the insecticide and actively moves away from the treated surface.
3. Genetic modification of the receptor protein so the insecticide can no longer bind.
4. Upregulation of enzymes that rapidly break down the toxicant before it reaches its target.
(A) P-4, Q-3, R-1, S-2
(B) P-3, Q-4, R-1, S-2
(C) P-4, Q-2, R-1, S-3
(D) P-1, Q-3, R-4, S-2

2005

111. Certain organophosphorus compounds, known as 'delayed neurotoxicants', induce a condition

2006

125. Consider the following statements regarding the physical and chemical properties of formulations:

I. A Wettable Powder (WP) must be agitated continuously to remain in suspension.

II. Emulsifiable Concentrates (EC) are fundamentally transparent, true solutions before being mixed with water.

III. Dust formulations are considered safer for pollinators than liquid sprays because they fall quickly to the ground.

IV. Suspension Concentrates (SC) avoid the use of hazardous volatile organic solvents.

Which of the above statement(s) is/are INCORRECT?

(A) I and II
(B) II and III
(C) III only
(D) IV only

2010

126. A farmer applies an organophosphate insecticide and observes that it effectively controls leaf miners that are feeding entirely within the plant tissue, even though the chemical was only applied to the leaf surface. What property does this insecticide possess?

(A) High vapor pressure (Fumigant action)
(B) Repellent activity
(C) Translaminar activity (Local systemicity)
(D) Growth regulating activity

2007

127. Which of the following is considered an indirect hazard of pesticide misuse in an agricultural ecosystem?

(A) Acute poisoning of the farm worker that occurs during the initial spray application in the field.
(B) Catastrophic decline of honey bee populations leading to reduced crop pollination and yield.
(C) Contamination of the local drinking water well through the immediate drift of the chemical spray.
(D) Chemical burn or phytotoxicity on the leaves of the treated crop caused by the applied pesticide.

2021

128. What is the precise function of a "safener" when incorporated into certain agrochemical formulations?

(A) It increases the mammalian LD50 of the active ingredient, making it safer for the applicator to handle.
(B) It completely temporarily neutralizes the active ingredient if the formulation is accidentally ingested by a human.
(C) It encapsulates the active ingredient to prevent its rapid degradation by exposure to ultraviolet light.
(D) It protects the target crop from phytotoxicity caused by the insecticide without reducing its efficacy.

2007

129. By standard chemical classification, endosulfan is unique among organochlorines because it contains an atom of which element in its cyclic structure?

(A) Sulfur
(B) Nitrogen
(C) Phosphorus
(D) Fluorine

2025

130. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): The Maximum Residue Limit (MRL) is not fundamentally a toxicological safety limit, but rather an agronomic standard indicating Good Agricultural Practice (GAP) was followed.

Reason (R): Consuming a product marginally exceeding the MRL does not automatically mean a direct health hazard, as the ADI incorporates large safety margins.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2017

131. In the context of insecticide transport within the insect hemolymph, how are highly lipophilic compounds typically mobilized?

(A) They bind to specific transport proteins known as lipophorins.
(B) They dissolve completely as free ions in the aqueous hemolymph plasma.
(C) They are exclusively transported inside the hemocytes.
(D) They are converted into gaseous forms and transported via the tracheal system.

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notorious for their high mammalian toxicity and extensive environmental persistence?
(A) Hexachlorocyclohexanes (HCH)
(B) Diphenyl aliphatics
(C) Cyclodienes
(D) Formamidines

2002

147. A primary feature of Phase I metabolism is the introduction of reactive functional groups into the toxicant molecule. Which specific functional groups are most commonly introduced or exposed?
(A) -OH, -COOH, -NH2, or -SH
(B) -CH3, -CH2CH3, or -CF3
(C) Heavy metals such as Pb or As
(D) Aromatic benzene rings

2004

148. Which factor is most crucial in determining the rate of spiracular entry (fumigant action) of an insecticide into the insect body?
(A) The molecular weight of the active ingredient.
(B) The exact thickness of the insect epicuticular wax layer.
(C) The pH of the insect midgut fluid.
(D) The vapor pressure of the insecticidal compound at ambient temperature.

2019

149. How does the application of 'safeners' in tank mixes primarily alter the physiological response of the target organism?
(A) It triggers the rapid desiccation of the insect cuticle by disrupting the protective epicuticular wax layer.
(B) It enhances detoxification enzyme expression (e.g., GSTs or P450s) in the crop but not the pest.
(C) It chemically bonds with the insecticide molecule, rendering it completely insoluble in the spray water.
(D) It physically blocks the stomata of the plant, preventing the entry of any toxic vapors into the tissues.

2003

150. Identify the INCORRECT statement describing the fundamental principles of probit analysis as introduced by Finney.
(A) It assumes that the logarithms of individual tolerances in a population are normally distributed.
(B) Probit 5 strictly corresponds to the LD50 value.
(C) It requires an infinite number of test subjects to derive mathematically valid statistics.
(D) It transforms a sigmoid dose-response curve into a straight regression line to calculate median lethal doses accurately.

NODIA

2019

151. Why are synthetic pyrethroids classified strictly into Type I and Type II categories?
(A) Based solely on their chronological generation of discovery and release to the commercial market.
(B) Based on their overall solubility in non-polar organic solvents versus their solubility in water.
(C) Based on their current authorization status as defined in the legacy Insecticides Act of 1968.
(D) Based on the absence (Type I) or presence (Type II) of an alpha-cyano group, causing different syndromes.

2022

152. In evaluating the environmental dynamics of an active ingredient, the 'Koc' value is heavily scrutinized. What does a highly elevated 'Koc' value signify?
(A) It signifies high affinity for soil organic carbon, indicating low potential for leaching into groundwater.
(B) The pesticide is considered highly volatile and will quickly dissipate from the soil into the atmosphere.
(C) The pesticide is extremely soluble in water and possesses a very high potential for leaching into aquifers.
(D) The pesticide is rapidly and completely degraded by photolysis on the surface of the soil within days.

2017

153. Which international environmental treaty aims to protect human health and the environment from Persistent Organic Pollutants (POPs), including several legacy organochlorine insecticides?
(A) The Montreal Protocol
(B) The Stockholm Convention
(C) The Kyoto Protocol
(D) The Cartagena Protocol

2004

154. Which specific class of esterases is primarily responsible for the rapid degradation of malathion in mammalian systems, conferring its selective physiological safety?

compound.
(C) To determine the precise degradation rate and half-life of the insecticide in the soil environment.
(D) To evaluate the physiological safety and phytotoxicity of the formulation on the target crop species.

2002

140. Match the insecticide regulatory bodies in List I with their defining functions in List II.
List I: (Regulatory bodies)
P. Central Insecticides Board (CIB)
Q. Registration Committee (RC)
R. Central Insecticides Laboratory (CIL)
S. Insecticide Inspector
List II: (Defining functions)
1. Grants registration of insecticides after scrutinizing their safety and efficacy.
2. Advises the Central/State Governments on technical matters related to pesticide use.
3. Carries out statutory testing of field pesticide samples to determine chemical quality.
4. Enforces the Act by conducting inspections and drawing samples from the market.
(A) P-2, Q-1, R-3, S-4
(B) P-1, Q-2, R-3, S-4
(C) P-2, Q-4, R-1, S-3
(D) P-1, Q-3, R-2, S-4

2002

141. The biochemical process of 'induction' regarding insect detoxification enzymes refers to:
(A) The genetic mutation of the enzyme's active site to prevent the insecticide from binding correctly.
(B) The rapid physical transport of enzymes from the hemolymph to the cuticle to block chemical entry.
(C) The immediate destruction of enzymes by the insecticidal binding within the nervous system tissues.
(D) Increased synthesis/activity of detoxification enzymes triggered by sublethal exposure to xenobiotics.

2007

142. Carbamate insecticides inhibit acetylcholinesterase in a manner fundamentally similar to organophosphates. However, carbamate poisoning is generally considered clinically easier to manage because:
(A) Carbamates only inhibit peripheral AChE and cannot cross the blood-brain barrier to affect the brain.
(B) Carbamates are immediately neutralized and metabolized by circulating blood glucose in the body.
(C) The carbamylated enzyme undergoes spontaneous reactivation much faster than a phosphorylated one.
(D) Carbamates target the nicotinic acetylcholine receptors rather than the muscarinic acetylcholine receptors.

2001

143. Which of the following analytical concepts refers to the lowest concentration of a pesticide residue that can be reliably quantified with acceptable precision and accuracy in a specific matrix?
(A) Limit of Detection (LOD)
(B) Limit of Quantification (LOQ)
(C) Maximum Residue Limit (MRL)
(D) Acceptable Daily Intake (ADI)

2010

144. Which process represents the primary pathway for the natural abiotic degradation of modern synthetic pyrethroids in the agricultural environment?
(A) Bacterial hydrolysis in anaerobic soils.
(B) Leaching below the root zone into deep groundwater aquifers.
(C) Rapid volatilization into the upper atmosphere.
(D) Photochemical degradation (photolysis) induced by ultraviolet radiation.

2008

145. Consider the following steps in the QuEChERS residue extraction protocol:
I. Dispersive Solid Phase Extraction (d-SPE) for clean-up.
II. Addition of extraction solvent (e.g., Acetonitrile).
III. Homogenization of the analytical sample.
IV. Addition of partitioning salts (e.g., Magnesium sulfate, Sodium chloride) and centrifugation.
What is the correct hierarchical order of these steps?
(A) III, II, IV, I
(B) II, III, IV, I
(C) III, IV, II, I
(D) II, IV, III, I

2010

146. Which structural classification encompasses insecticides like Endrin, Aldrin, and Dieldrin,

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2018

132. Among the formulations listed, which one presents the lowest risk of inhalation exposure to the applicator while preparing the spray mixture?
(A) Wettable Powder (WP)
(B) Dust (D)
(C) Soluble Powder (SP)
(D) Water Dispersible Granules (WDG)

2022

133. Which of the following is considered a correct statement regarding the mechanism of cross-resistance?
(A) It requires the insect to possess multiple and genetically distinct resistance mechanisms simultaneously.
(B) It occurs between insecticides sharing a common target site or metabolic degradation pathway.
(C) It only occurs between insecticides that are manufactured and marketed by the same chemical company.
(D) It is an ecological phenomenon where resistance in one pest species induces resistance in another species.

2001

134. Which mathematical value represents the slope of the probit regression line, indicating the heterogeneity of the tested insect population's response to the toxicant?
(A) A highly steep slope indicates a highly heterogeneous population with varied susceptibility to the chemical.
(B) A flat or shallow slope indicates a highly homogeneous and uniformly susceptible population of insects.
(C) A steeper slope indicates a homogeneous population where individuals react similarly to small dose changes.
(D) The slope has no statistical relationship to population heterogeneity and only determines the LD50 value.

2014

135. Consider the following statements regarding systemic insecticides:
I. They must possess sufficient water solubility to move within the plant's vascular system.
II. They are completely ineffective against phloem-feeding insects like aphids and whiteflies.
III. They protect new, emerging plant tissues that develop after the initial spray application.
IV. They are rapidly degraded by the plant's photosynthetic machinery within hours.
Which of the above statement(s) is/are correct?
(A) I and II
(B) I and III
(C) II and IV
(D) I, III and IV

2019

136. What is the defining characteristic of an 'additive joint action' when mixing two distinct insecticidal compounds?
(A) The total observed toxicity equals the mathematical sum of the individual toxicities of the components.
(B) The total observed toxicity is significantly greater than the mathematical sum of their individual toxicities.
(C) The total observed toxicity is significantly less than the toxicity of the most active single component used.
(D) The compounds chemically react in the tank to form an entirely new and different toxic pesticide molecule.

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2006

137. Which of the following toxicological parameters is mathematically derived by dividing the No Observed Adverse Effect Level (NOAEL) by standard uncertainty/safety factors (usually 100)?
(A) Maximum Residue Limit (MRL)
(B) Acceptable Daily Intake (ADI)
(C) Median Lethal Dose (LD50)
(D) Half-life (RL50)

2002

138. Under physiological conditions, acetylcholinesterase rapidly hydrolyzes the neurotransmitter acetylcholine into which two products?
(A) Acetyl-CoA and choline
(B) Acetic acid and choline
(C) Acetate and muscarine
(D) Butyric acid and choline

2002

139. In the design of toxicity testing methods, what is the primary purpose of applying a 'diagnostic dose' or 'discriminating dose'?
(A) To distinguish between resistant and susceptible individuals in a field population sample.
(B) To calculate the exact and precise LD50 value of a newly discovered chemical toxicant

(A) Arylesterases
(B) Carboxylesterases (Aliesterases)
(C) Cholinesterases
(D) Acetylesterases

2006

155. According to the provisions of the Insecticides Act (1968), an insecticide is legally deemed "misbranded" under which of the following conditions?
(A) If its label contains any statement, design, or graphic relating to the insecticide which is false or misleading.
(B) If it is sold in an authorized, tightly sealed, and completely unadulterated container from the manufacturer.
(C) If it strictly complies with the specific registration certificate granted by the Registration Committee.
(D) If the toxicological color band on the label perfectly matches the LD50 classification of the formulation.

2021

156. The biochemical resistance mechanism involving an altered acetylcholinesterase (modified AChE) primarily confers cross-resistance to which two classes of insecticides?
(A) Pyrethroids and Organochlorines
(B) Neonicotinoids and Spinosyns
(C) Organophosphates and Carbamates
(D) Benzoylureas and Diacylhydrazines

2005

157. Identify the biological pest management strategy that deliberately leverages an established "waiting period" (PHI).
(A) The augmentative release of biological control agents into the field immediately following a chemical spray.
(B) Applying multiple synergistic chemicals continuously and repeatedly until the very day of the harvest.
(C) Irradiating the harvested crop with gamma rays to neutralize persistent chemical molecules in the tissue.
(D) Allowing time for residues to degrade naturally to non-toxic levels before the crop is harvested.

2024

158. Which of the following analytical detectors is most highly specific for the quantification of organophosphorus pesticide residues in gas chromatography (GC)?
(A) Thermal Conductivity Detector (TCD)
(B) Electron Capture Detector (ECD)
(C) Flame Photometric Detector (FPD) in phosphorus mode
(D) Ultraviolet-Visible Detector (UV-Vis)

2001

159. What is the specific role of synergists like PBO or DEF when utilized as diagnostic tools in laboratory resistance bioassays?
(A) To physically bind and precipitate the active ingredient, neutralizing it completely within the bioassay.
(B) To inhibit detoxification enzymes (P450s/ Esterases), helping identify the resistance mechanism.
(C) To act as a surrogate toxicant, replacing the primary active ingredient during the laboratory testing process.
(D) To dramatically increase the natural background mortality rate observed in the untreated control group.

2022

160. According to the WHO Recommended Classification of Pesticides by Hazard, a pesticide classified as "Class Ia" corresponds to which description?
(A) Extremely hazardous
(B) Highly hazardous
(C) Moderately hazardous
(D) Slightly hazardous

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powerful antifeedant, making the treated foliage unpalatable to pests. Additionally, it interferes with the endocrine system by blocking the release of molting hormones, which prevents larvae from pupating or developing into adults. These dual actions make it a highly effective tool.

18. (C) Mammalian carboxylesterases rapidly hydrolyze malathion into non-toxic carboxylic acid metabolites.
The safety of this organophosphate in mammals is due to differences in metabolic pathways between species. Mammals possess high levels of specific enzymes that quickly break down the parent compound into harmless water-soluble products. In contrast, insects slowly metabolize the chemical into its more toxic oxygen analogue, malaoxon. This differential rate of detoxification provides a wide margin of safety for humans.

19. (A) Spinosad — Avermectin
While both groups are derived from soil microorganisms, they belong to distinct chemical classes with different targets in the nervous system. The first compound belongs to the spinosyn group, which acts on nicotinic acetylcholine and GABA receptors. In contrast, the second group mentioned comprises macrocyclic lactones that primarily target glutamate-gated chloride channels. Correctly identifying these groups is essential for resistance management.

20. (A) P-4, Q-3, R-1, S-2
Toxicology uses various metrics to quantify the impact of chemicals on populations. The median lethal dose identifies the amount causing fifty percent mortality, while the knockdown dose refers to paralysis. Timing is measured by the period required to kill half the subjects, and the effective dose evaluates non-lethal responses. Understanding these parameters is fundamental for assessing the potency of different formulations.

21. (B) Deriving the Co-toxicity Coefficient (Sun and Johnson method).
Determining how two chemicals interact requires a standardized mathematical comparison of their combined toxicity against their individual effects. This specific coefficient calculates whether a mixture produces a response that is significantly higher than expected, indicating synergism, or lower, suggesting antagonism. This analysis is crucial for developing effective tank mixes and understanding the biochemical interactions between different modes of action in control.

22. (C) Logarithm of the dosage
Probit analysis is a statistical technique used to linearize the sigmoidal relationship found in biological assays. By converting percentages into probits and taking the log of the concentration, researchers can create a straight line. This linear model allows for the precise calculation of the median lethal dose and provides information about the susceptibility and homogeneity of the insect population tested.

23. (D) A point mutation in the voltage-gated sodium channel that reduces its toxicant sensitivity.
Resistance to DDT and pyrethroids often arises from changes at the nerve membrane level. A specific genetic alteration in the pore-forming subunit of sodium channels prevents these insecticides from binding effectively. This reduced affinity means the channels do not remain open long enough to cause the repetitive firing and paralysis typical of these neurotoxicants, allowing the insect to survive.

24. (A) ace-1 mutation
Resistance to organophosphates and carbamates can develop through the modification of the enzyme responsible for breaking down acetylcholine. A specific genetic change leads to an insensitive form of this esterase, which continues to function even in the presence of the toxicant. This target-site insensitivity prevents the lethal accumulation of neurotransmitters at the synapse, rendering the applied insecticides much less effective.

25. (D) IV only
The international classification system organizes insecticides based on their physiological targets to aid resistance management. Group one includes acetylcholinesterase inhibitors, while group three contains sodium channel modulators like pyrethroids and DDT. Rotating between these groups is a core strategy to prevent pest populations from developing resistance. Compound groups are designated by their specific biochemical modes of action rather than chemistry.

26. (B) Cross-resistance
This phenomenon occurs when a single genetic mechanism provides protection against multiple,

NODIA

and overall efficacy of foliar applications against various pest species.

9. (B) Endosulfan
Organochlorine insecticides are grouped into distinct chemical families including diphenyl aliphatics, hexachlorocyclohexanes, and cyclodienes. This specific sulfur-containing compound belongs to the cyclodiene group, characterized by a cyclic structure produced through the Diels-Alder reaction. While many organochlorines are banned globally due to environmental persistence, this insecticide was widely used for managing various agricultural pests before its eventually global phase-out.

10. (C) A is true but R is false.
Persistent organochlorines were restricted due to their tendency to bioaccumulate and resist environmental degradation. However, their high lipophilicity is actually a vital property that enables them to penetrate the waxy insect cuticle easily, making them effective contact poisons. Therefore, while the assertion regarding their phase-out is correct, the reasoning provided about their inefficiency due to lipophilicity is scientifically incorrect.

11. (A) Suspension Concentrate (SC)
This formulation type consists of finely ground solid active ingredients dispersed in a liquid medium, usually water. It requires the addition of wetting and dispersing agents to maintain stability and prevent the particles from settling over time. These products offer advantages such as being solvent-free and non-flammable, making them safer for both the environment and the user compared to concentrates.

12. (C) Midgut (Mesenteron)
The digestive tract of insects varies in physiological conditions between its three main regions. In many lepidopteran larvae, this central portion exhibits an exceptionally high alkalinity, which is essential for certain digestive processes. This alkaline environment also influences the solubility and activation of various stomach poisons, such as Bacillus thuringiensis toxins, which require specific pH levels to become biologically active.

NODIA

13. (D) Inhibition of mitochondrial electron transport at Complex I (NADH dehydrogenase).
This botanical compound is derived from the roots of certain legumes and acts as a potent respiratory toxin. It specifically disrupts the cellular energy production process by blocking the flow of electrons within the mitochondria. By preventing the conversion of nutrients into adenosine triphosphate, it causes cellular failure and eventual death in insects. This mechanism is highly specific to the respiratory chain.

14. (C) They are highly stable in soil environments, often persisting for several years without degradation.
Modern pyrethroids are designed to combine high insecticidal potency with relatively low environmental stability compared to older organochlorines. They are generally susceptible to photodegradation and microbial breakdown in the soil, meaning they do not persist for several years. Most formulations degrade within weeks or months, reducing long-term environmental accumulation while maintaining effective control during the initial period after application.

15. (A) I and II
This class of synthetic insecticides is modeled after nicotine and acts specifically on the central nervous system. They function as agonists at nicotinic acetylcholine receptors, causing overstimulation and paralysis. Their strong systemic movement within plant tissues allows them to protect against sap-sucking pests. However, they are not used as fumigants because they possess low volatility and rely on ingestion.

16. (D) Mimicking the action of the neurotransmitter octopamine.
These chemicals represent a unique class of neurotoxicants that interfere with aminergic signaling in the insect nervous system. They act as agonists at specific receptor sites, leading to behavioral changes such as hyper-excitability and detachment from the host plant. This mode of action is distinct from other common insecticide groups, providing an alternative tool for pest management and resistance mitigation.

17. (A) Feeding deterrent and insect growth disruptor
Extracted from the neem tree, this complex limonoid affects insects through multiple physiological pathways. It primarily acts as a

ANSWERS

1. (A) Schradan
Developed in the 1940s, this compound was the first organic phosphorus insecticide to demonstrate effective systemic movement within plants. It paved the way for modern systemic pest control by being absorbed and translocated to protect various tissues. This advancement was pivotal in establishing the organophosphate group as a cornerstone of chemical pest management strategies for several decades.

2. (C) Juvenile hormone analogues
The evolution of insecticide chemistry is divided into four distinct generations based on their mechanism and discovery timeline. Inorganic salts and botanicals comprise the first generation, while synthetic organics represent the second. The third generation includes biorational compounds like hormone analogues, and the fourth involves newer neurotoxicants like neonicotinoids. These categories help track the historical progress of pest control.

3. (A) POISON (Red)
Toxicity classification in India utilizes a color-coding system based on oral and dermal hazard levels. The extremely toxic category features a bright red triangle and the word poison, applied to substances with an oral median lethal dose under fifty milligrams per kilogram. This visual warning ensures proper safety protocols are followed during the handling, storage, and application of hazardous materials.

4. (D) They are non-aqueous liquid formulations with active ingredient, hydrophobic solvent, and emulsifier.
These liquid formulations consist of an active ingredient dissolved in a petroleum-based or organic solvent. They include surface-active agents that allow the hydrophobic mixture to form a stable emulsion upon dilution with water. This physical characteristic facilitates uniform spraying and enhances the ability of the toxicant to penetrate the insect cuticle or leaf surface efficiently during agricultural applications in the field.

5. (A) Partitioning into the epicuticular wax → Diffusion through the procuticle → Transport via hemolymph → Target site binding
Contact insecticides must navigate several barriers to reach their molecular targets. The process begins as the chemical dissolves into the outermost lipophilic wax layer. Subsequently, the toxicant diffuses through the proteinaceous and chitinous procuticle. Once inside the body cavity, it is transported by the hemolymph to the nervous system or other specific sites where it binds and exerts lethal toxicity.

6. (C) WDGs minimize inhalation hazards during handling by being virtually dust-free.
Modern formulation technology prioritizes applicator safety by reducing potential exposure routes. Water dispersible granules consist of dry particles that break down in water but remain intact during pouring and measurement. Unlike traditional powders, they do not produce airborne dust clouds, significantly lowering the risk of respiratory ingestion. This improvement in occupational health is a major factor in their widespread adoption.

7. (D) They possess high inherent insecticidal toxicity when applied independently.
Synergists are non-toxic chemicals added to pesticide formulations to enhance the potency of the active ingredient. They function primarily by inhibiting metabolic enzymes like cytochrome P450 monooxygenases, which normally detoxify the insecticide within the insect body. By preventing this degradation, the synergist allows a higher concentration of the toxicant to reach the target site, effectively increasing its overall lethality and efficacy.

8. (A) To lower dynamic surface tension, ensuring the spray droplet spreads evenly over leaf surfaces.
Wetting agents are specialized surfactants that reduce the surface tension of water-based spray mixtures. This reduction allows droplets to flatten and spread across waxy leaf surfaces rather than bead up and roll off. By increasing the contact area between the toxicant and the foliage, these additives improve the coverage

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often chemically unrelated, insecticides. It usually stems from a shared target site or a common metabolic pathway that can detoxify different molecules. Consequently, exposure to one chemical can lead to a population becoming resistant to another that it has never encountered, complicating the design of effective management programs.

27. (A) Modifying the timing and placement of pesticide application to avoid exposing natural enemies.
Achieving selectivity in pest management involves protecting beneficial organisms while controlling pests. This approach relies on tactical adjustments rather than the innate properties of the chemical. By applying treatments when natural enemies are inactive or placing them only where pests aggregate, farmers can reduce non-target mortality. This strategy is a fundamental component of integrated programs that balance agricultural chemical use.

28. (C) Conjugation of toxicants with glutathione catalyzed by glutathione S-transferases.
Insect detoxification involves two primary stages of chemical transformation. The second stage focuses on making metabolic intermediates more polar and water-soluble to facilitate excretion. This is achieved by attaching endogenous molecules, such as peptides or sugars, to the toxicant. These reactions, performed by specialized transferases, effectively neutralize the chemical and prevent its accumulation within the lipid-rich tissues of the body.

29. (D) Secondary pest outbreak
The use of non-selective insecticides can disrupt the ecological balance within a crop. When broad-spectrum chemicals eliminate the predators and parasites that normally keep minor pests in check, those minor species may rapidly multiply and reach damaging levels. This shift creates a new pest problem where none previously existed, illustrating the risks associated with the loss of natural biological control.

30. (C) A is true but R is false.
Type two pyrethroids, which contain an alpha-cyano group, induce a specific set of symptoms in insects including twisting tremors and salivation. Unlike type one compounds that cause repetitive nerve firing, type two molecules cause a prolonged depolarization of the nerve membrane by holding sodium channels open for extended periods. This fundamental difference in their neurophysiological impact leads to the distinct syndromes.

31. (B) The time required for the initial pesticide concentration in the environment to be reduced by half.
Environmental persistence is often quantified using first-order kinetics, where the rate of disappearance is proportional to the concentration present. The median residual life, or half-life, represents the duration needed for fifty percent of the applied chemical to degrade or dissipate. This parameter is essential for predicting how long residues will remain in soil or water after a pesticide treatment.

32. (D) The degradation curve of the residue and the legally established MRL.
Establishing the safety interval between the last application and harvest requires scientific data on how quickly a chemical breaks down. By plotting the disappearance of residues over time, regulators can determine the exact point when concentrations fall below the maximum residue limit. This ensures that food products reaching consumers do not contain levels of pesticides that exceed legally permissible safety standards.

33. (A) Quick, Easy, Cheap, Effective, Rugged, and Safe
This modern analytical approach has revolutionized the way laboratories prepare food and environmental samples for pesticide testing. It combines streamlined extraction and clean-up steps to handle a wide range of compounds simultaneously. The name reflects the methodological benefits of the system, which prioritizes speed and reliability without sacrificing the accuracy needed for detecting trace levels of contaminants in complex matrices.

34. (C) Electron Capture Detector (ECD)
This specific gas chromatography detector is highly sensitive to compounds containing electronegative atoms, particularly halogens like chlorine. Because organochlorine insecticides are heavily chlorinated, they produce a strong signal even at extremely low concentrations. This makes it the preferred tool for monitoring trace residues of persistent pollutants in environmental samples, where high specificity and a low detection limit are required.

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35. (B) I, II, IV and V
Pesticide regulation involves multiple international and domestic agencies. International standards are set by the Codex Commission, while domestic limits in India are managed by the food safety authority. Scientific evaluation of toxicology is provided by expert joint meetings of global health and agriculture organizations. These bodies collaborate to ensure that residue limits protect consumer health while facilitating fair trade.

36. (D) It competitively blocks muscarinic receptors, preventing overstimulation by excessive acetylcholine.
Organophosphate poisoning leads to an accumulation of neurotransmitters at the synapse, causing continuous nerve stimulation. This antidote works by binding to specific receptor sites on the post-synaptic membrane, effectively blocking the excess acetylcholine from interacting with them. By antagonizing these receptors, it relieves life-threatening symptoms such as respiratory distress and excessive secretions, although it does not fix the enzyme inhibition.

37. (B) Inducing vomiting regardless of the chemical nature of the ingested pesticide formulation.
Emergency response for poisoning requires careful consideration of the specific toxicant involved. Forcing a patient to vomit is dangerous if they have consumed corrosive substances or petroleum-based solvents, as this can cause severe tissue damage or aspiration pneumonia. First-aid should focus on stabilization, decontamination of skin, and moving the victim to fresh air while waiting for professional medical intervention.

38. (C) Registration Committee (RC)
Under Indian law, this statutory body is responsible for the formal approval of insecticides. It evaluates extensive data regarding the bio-efficacy of the product against target pests and its safety for humans, animals, and the environment. Only after this committee is satisfied with the provided evidence is a registration certificate issued, allowing the legal manufacture and sale of the chemical.

39. (D) It introduces a provision to compensate farmers in cases of crop loss caused by sub-standard or spurious pesticides.
Proposed updates to national pesticide laws aim to enhance accountability and protect agricultural livelihoods. A key reform includes the creation of a mechanism where farmers can seek financial redress if their crops are damaged by poor-quality or mislabeled chemicals. This shift addresses long-standing concerns regarding the impact of ineffective products and strengthens the regulatory oversight of the entire pesticide industry.

40. (A) P-2, Q-4, R-3, S-1
Different classes of neuroactive insecticides target specific components of the insect nervous system. Some modulate sodium channels by keeping them open, while others block these channels entirely. Certain compounds act as antagonists at inhibitory chloride channels or block excitatory acetylcholine receptors. Understanding these diverse molecular targets is essential for developing effective pest control strategies and managing the emergence of resistance.

41. (B) Pyrroles (e.g., Chlorfenapyr)
This class of chemicals functions as pro-insecticides that are activated within the insect body. Once converted, the active form enters the mitochondria and disrupts the proton gradient necessary for energy synthesis. By uncoupling oxidative phosphorylation, the chemical prevents the production of adenosine triphosphate, leading to cellular exhaustion and death. This unique mechanism is effective against pests resistant to neurotoxicants.

42. (B) Tebufenozide
This insect growth regulator mimics the natural molting hormone by binding to its specific receptor. When larvae ingest the compound, it triggers the initiation of a molt prematurely, even when the insect is not physiologically ready. The resulting incomplete and lethal shedding of the cuticle leads to death. This highly selective mechanism primarily affects lepidopteran species while remaining safe for beneficials.

43. (A) Octanol-water partition coefficient ($K_{\{ow\}}$)
This chemical parameter measures how a substance distributes itself between a non-polar solvent and water. It serves as a crucial

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indicator of lipophilicity, predicting how easily an insecticide can move from the aqueous environment of the hemolymph into the fatty tissues or the waxy cuticle. Higher values suggest a stronger affinity for lipids, which influences the absorption, transport, and bioaccumulation.

44. (C) Synthetic Pyrethroids
Some insecticides exhibit a unique relationship with ambient conditions where their lethality decreases as temperatures rise. This negative temperature coefficient is most notably observed in this class of neurotoxicants. Higher temperatures can increase the rate of metabolic detoxification or alter the sensitivity of the sodium channels, reducing the overall efficacy. Applicators must consider this factor when timing their sprays.

45. (B) II, III, I, IV
The development of pyrethroids followed a progression from early synthetic mimics of natural pyrethrins to highly stable and potent modern molecules. The timeline started with compounds like allethrin, followed by more refined versions like resmethrin. Later generations introduced greater light stability and high efficacy, such as deltamethrin, and finally, specialized fluorinated molecules. This chronology reflects advancements in chemical stability.

46. (C) Systemic insecticides move via the xylem to unsprayed parts, while translaminar ones move locally across leaf surfaces.
Movement within plant tissues differentiates these two categories of pesticides. Truly systemic chemicals are absorbed and transported through the vascular system, often via the xylem, to protect newly growing foliage. In contrast, those with local activity only pass through the leaf blade from the treated upper surface to the untreated lower side. Both properties help control pests in protected areas.

47. (B) Coalitive action
Synergism in toxicology can manifest in various forms depending on the properties of the individual components. This specific term describes a situation where two substances that are individually harmless produce a significant toxic effect when they are combined. This interaction is distinct from simple potentiation or additive effects, representing a unique biochemical cooperation that results in lethal toxicity from inert materials.

48. (D) Rotenone — Derris elliptica
Many effective insecticides are derived from natural plant sources. This specific respiratory toxin is extracted from the roots of tropical legumes in this genus. Historically used as a fish poison, it has been adapted for agricultural use due to its rapid breakdown and effectiveness against various pests. Understanding the botanical origins of these compounds is essential for identifying natural alternatives.

49. (A) It involves loss of an alkyl group, making the OP-enzyme bond irreversible and resistant to oximes.
After an organophosphate binds to acetylcholinesterase, a secondary chemical change can occur over time. This process stabilizes the attachment between the toxicant and the enzyme, effectively locking it in an inactive state. Once this structural change is complete, the enzyme can no longer be reactivated by standard antidotes like oximes. Medical management must therefore be initiated quickly before irreversibility.

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50. (C) I only
Adjuvants are essential additives that modify the physical properties of a pesticide mixture. Emulsifiers allow oily active ingredients to remain dispersed in water, which is critical for formulation stability. While other additives like spreaders and stickers enhance coverage and rainfastness, they do so by lowering contact angles or increasing adhesion. Incorrectly identifying these functions can lead to poor spray performance.

51. (A) A stimulatory effect on the reproduction of pests resulting from exposure to sub-lethal doses of an insecticide.
Low-level chemical stress can sometimes have counterintuitive effects on biological systems. When insects are exposed to amounts of a toxicant that do not cause mortality, their physiological response may include an increase in egg production or faster development. This unintended stimulation can lead to rapid population growth and pest resurgence, undermining the goals of an integrated management program.

122. (B) A Prerequisite Program (PRP) or Chemical CCP used to ensure residues do not exceed legal MRLs.
Systematic approaches to food safety manage potential chemical hazards by establishing strict control measures. Pesticide residues are handled as part of foundational programs that ensure chemicals are applied correctly and that final products are monitored for compliance. By identifying these critical points in the production process, manufacturers can prevent contaminated food from reaching the market and protect consumers.

123. (A) They increase the penetrability of the toxicant through the cuticle by acting as organic solvents.
These additives are used to improve the performance of insecticides without having any toxic effects themselves. Their main role is to interfere with the metabolic pathways that insects use to detoxify chemicals. By blocking enzymes like oxidases or esterases, they ensure that more toxicant remains active. While they assist the pesticide, they do not function as organic cuticle solvents.

124. (C) Molecular oxygen and a reducing agent (typically NADPH).
The metabolic activity of these vital enzymes requires specific cofactors to function. During the catalytic cycle, one atom of an oxygen molecule is incorporated into the toxicant substrate, while the other is reduced to form water. This process is powered by a steady supply of energy from a specific electron donor. These components allow the enzyme to detoxify pesticide molecules.

125. (C) III only
Formulations vary in their physical properties and their impact on the environment and beneficial insects. While some require constant mixing to stay in suspension, others are stable liquids. The idea that dry particles are safer for pollinators is incorrect, as fine dusts can easily drift and contaminate flowers, leading to high bee mortality. Applicators must choose formulations to minimize risks.

126. (C) Translaminar activity (Local systemicity)
Certain pesticides have the ability to move through the leaf tissue from the surface where they were applied to the opposite side. This local movement allows the chemical to reach insects that are feeding internally or on the underside of the foliage. While not truly systemic, this property is highly effective for controlling miners and other pests shielded from direct contact.

127. (B) Catastrophic decline of honey bee populations leading to reduced crop pollination and yield.
The misuse of insecticides can have cascading effects on the agricultural ecosystem that go beyond the immediate killing of pests. When non-selective chemicals harm beneficial insects like pollinators, it can lead to a decrease in crop quality and quantity. This loss of essential ecosystem services represents an indirect hazard that impacts the long-term sustainability and productivity of the agricultural environment.

128. (D) It protects the target crop from phytotoxicity caused by the insecticide without reducing its efficacy.
These specialized additives are used in agrochemical formulations to improve their compatibility with the treated plants. They work by enhancing the plant's natural ability to detoxify the active ingredient through metabolic pathways. This selective protection prevents the crop from suffering chemical burns or other damage while allowing the insecticide to remain lethal to the targeted pests, ensuring crop health.

129. (A) Sulfur
This chlorinated insecticide is unique among its chemical relatives because its cyclic structure contains a specific non-halogen atom. This presence of an inorganic element as part of a central ester group influences its biological activity and environmental behavior. Although it belongs to the cyclodiene family, this structural feature contributes to its effectiveness against a wide range of agricultural pests.

130. (A) Both A and R are true and R is the correct explanation of A.
The legal limit for residues on food is primarily an indicator of whether a pesticide was used according to approved agricultural practices. It is not a direct measure of toxicity, as it is set far below levels that would pose a health risk. This ensures that food safety is maintained while allowing for the practical use of chemicals.

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61. (D) The highest experimental dose that produces no statistically significant adverse effects in animal toxicity studies.
Risk assessment relies on identifying the threshold at which a chemical begins to cause harm. During long-term feeding studies in laboratory animals, researchers look for the maximum dose that does not result in any measurable physiological or behavioral changes. This value serves as the starting point for calculating human safety limits, such as the acceptable daily intake, by applying safety factors.

62. (C) The peritrophic matrix and midgut epithelium
For a stomach poison to be effective, it must pass from the gut lumen into the body cavity. The insecticide first encounters a semi-permeable lining that protects the gut cells before crossing the cellular layer of the midgut itself. These structures represent the final biological hurdles before the toxicant enters the hemolymph and is distributed to the nervous system or target organs.

63. (B) They catalyze the conjugation of toxicants with glutathione, making them more water-soluble for easier excretion.
These Phase II enzymes play a crucial role in detoxifying a wide range of xenobiotics. By attaching a tripeptide molecule to the insecticide or its metabolites, they significantly increase the polarity of the resulting complex. This transformation prevents the toxicant from re-entering cells and facilitates its rapid elimination from the insect's body, often contributing to the development of metabolic resistance in pests.

64. (D) To ensure susceptible insects that mate with resistant ones, diluting resistance alleles in the population.
Managing resistance in transgenic crops involves planting non-modified plants alongside the treated ones. This area provides a sanctuary where individuals not under selection pressure can thrive. When these susceptible insects breed with the rare resistant survivors from the treated field, the resulting offspring are more likely to be susceptible. This strategy effectively slows down the spread of resistance genes in populations.

65. (A) P-2, Q-4, R-1, S-3
Botanical insecticides are valued for their natural origins and unique chemical profiles. Neem provides complex limonoids, while tobacco is the source of potent alkaloids. Flowers in the chrysanthemum family yield several esters, and the roots of certain legumes produce respiratory toxins. These diverse active principles allow for the development of biopesticides that can target various physiological systems in pests.

66. (C) Through the spiracles and into the tracheal system during respiration.
Gaseous pesticides are highly effective because they can penetrate small spaces and enter pests through their respiratory openings. Once inside, the gas moves through the network of air tubes, allowing for rapid absorption into the tissues. This route of entry bypasses the protective cuticular barrier, making these chemicals particularly useful for controlling insects in stored grains, wood, or soil.

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67. (A) Repeated applications enrich soil microbes that rapidly metabolize the pesticide as a carbon source.
The effectiveness of soil treatments can decline over time due to changes in the local microbial community. When the same chemical is used frequently, certain bacteria and fungi may adapt to use the toxicant as an energy or nutrient source. This leads to an increase in their population, resulting in the rapid breakdown of the pesticide and reduced pest control.

68. (D) Maximum Residue Limit (MRL)
Regulatory authorities establish specific thresholds for the amount of pesticide that can remain on a crop at the time of sale. This limit is determined based on both toxicological data and trials that follow good agricultural practices. It serves as a legal standard to ensure food safety and to verify that chemicals were applied correctly during agricultural production.

69. (B) It allows analysis of thermally unstable, polar, and non-volatile pesticides without needing derivatization.
Modern residue analysis often utilizes liquid chromatography paired with mass spectrometry to overcome the limitations of gas-based systems. This combination can detect a broader range of pesticides, particularly those that would decompose when heated in a gas chromatograph. By eliminating the need for complex chemical modifications before testing, this technique

streamlines the laboratory process while maintaining high accuracy.

70. (D) II and III
National insecticide laws specify the roles of various committees and levels of government. While state governments enforce the act, the power to grant registration certificates for new chemicals rests solely with the central registration committee. Additionally, the board responsible for technical advice is a large body comprising numerous experts. Understanding these distinct legal jurisdictions is essential for regulatory compliance.

71. (D) It targets biological processes specific to pests, showing minimal toxicity to humans and non-target species.
This category of pest control agents focuses on compounds that are selective and environmentally compatible. By exploiting the physiological differences between pests and beneficial organisms, these chemicals reduce the risk of harm to humans and the ecosystem. Examples include growth regulators and pheromones, which disrupt specific life stages or behaviors. Such tools are highly valued within integrated management.

72. (A) Cytochrome P450 monooxygenases
Metabolic resistance often involves the overproduction of enzymes that can chemically alter insecticides. This diverse family of oxidase enzymes is capable of detoxifying a wide range of synthetic chemicals by introducing functional groups through oxidation. Enhanced activity of these proteins allows the insect to degrade the toxicant before it can reach its target site, leading to field control failure.

73. (B) Salivation, lacrimation, urination, defecation, GI motility, and emesis (SLUDGE).
Acute exposure to certain neurotoxicants causes a predictable set of clinical signs resulting from the overstimulation of the parasympathetic nervous system. This condition occurs when excessive neurotransmitters accumulate at specific receptors, leading to uncontrolled bodily secretions and gastrointestinal distress. Recognizing this characteristic pattern of symptoms is essential for rapid diagnosis and the timely administration of life-saving treatments.

74. (B) They nucleophilically attack the OP-enzyme complex, releasing the organophosphate and reactivating the enzyme.
In cases of organophosphate poisoning, these specialized antidotes are used to restore the function of the inhibited acetylcholinesterase. They work by physically removing the toxicant from the enzyme's active site, provided the bond has not yet undergone the permanent change known as aging. By freeing the enzyme, they allow it to resume its role in breaking down neurotransmitters.

75. (A) Field bio-efficacy trials → Submission of dossier to Registration Committee (RC) → Scrutiny by experts → Issuance of Certificate of Registration under Section 9
Bringing a new pesticide to the market involves a rigorous multi-stage regulatory process. It begins with extensive field testing to prove the product's effectiveness and safety. All resulting data is compiled into a detailed dossier and submitted to a central authority. After a thorough review by technical experts to ensure the chemical meets all legal requirements, a certificate is granted.

76. (C) Hazard concerns mean these can only be purchased and applied by certified, trained applicators.
Some pesticides are restricted due to their potential for high toxicity or environmental harm. These products are not available to the general public and require specialized training for their use. Only individuals who have demonstrated the necessary knowledge to handle these chemicals safely can legally purchase and apply them. This regulation ensures that highly hazardous materials are managed by professionals.

77. (D) Synergism
Joint action between two chemicals is evaluated by comparing their combined performance to their individual toxicities. If the calculated coefficient is significantly higher than one hundred, it indicates that the mixture is much more lethal than the sum of its parts. This cooperative effect is often exploited in pesticide formulations to increase efficacy against resistant pests or to reduce the required dose.

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78. (C) They possess particle sizes from 10 to 50 micrometers and low concentrations (1-5%) of active ingredient.
This dry formulation consists of a very low percentage of the active ingredient mixed with a finely ground inert carrier, such as talc or clay. The small particle size allows the material to be blown onto target areas using specialized equipment. While convenient for certain applications, these products are prone to wind drift and are not designed for dilution.

79. (B) LC50 (Median Lethal Concentration)
While the lethal dose measures the amount of chemical per unit of body weight, some environments require a different metric. When testing toxicity in the air or water, researchers measure the concentration of the substance within that medium. The value that kills fifty percent of the test population under these conditions is used to assess the risks posed to aquatic life.

80. (A) Both A and R are true and R is the correct explanation of A.
Organophosphates are generally less persistent in the environment than older chlorinated compounds. This is because their chemical structure contains sensitive ester bonds that are easily broken down by moisture through hydrolysis. Additionally, soil microorganisms can rapidly metabolize these compounds. This instability means they do not typically accumulate in the food chain, making them a preferred choice for modern agriculture.

81. (A) A bioassay strictly determines the chemical structure of the unknown toxic compound.
A biological assay is a tool used to measure the potency of a substance based on its effect on living organisms. It provides information about the toxicity and biological response but does not reveal the underlying chemical structure of the molecule. For identifying the specific atoms and bonds within a compound, analytical techniques like mass spectrometry or resonance are required instead.

82. (A) $\text{Corrected\%} = \left[\frac{\%\text{Test Mortality} - \%\text{Control Mortality}}{100 - \%\text{Control Mortality}}\right] \times 100$
Bioassay results must be adjusted to account for the deaths that occur naturally in the untreated control group. This mathematical formula subtracts the control mortality from the test results and divides by the percentage of survivors in the control. This normalization ensures that the reported mortality truly reflects the impact of the insecticide rather than external environmental factors or background death.

83. (A) Microencapsulated Suspensions (CS)
This advanced formulation technique involves creating tiny droplets of the active ingredient and surrounding them with a thin polymeric shell. By using specialized chemical reactions at the droplet interface, manufacturers can control how quickly the toxicant is released. This technology improves safety for the user, reduces environmental loss, and can extend the period of pest control through sustained release.

84. (D) Nereistoxin analogues (e.g., Cartap, Thiocyclam)
Some synthetic insecticides are based on natural toxins found in marine life. Scientists discovered a potent neurotoxicant in certain sea worms and developed synthetic versions that act similarly. These chemicals work by blocking the nicotinic acetylcholine receptors in the insect's nervous system, causing paralysis. They are particularly effective against lepidopteran pests and offer a different mode of action from common groups.

85. (B) I and III
This class of neurotoxicants, which includes phenylpyrazoles and older cyclodienes, interferes with inhibitory signaling in the nervous system. They function as antagonists at the chloride channels gated by gamma-aminobutyric acid, effectively blocking them. By preventing the normal dampening of nerve signals, these chemicals cause overstimulation, convulsions, and death. They are effective against many pests but do not keep channels open.

86. (C) It causes an irreversible block of the salivary pump and stylet function, causing death by starvation.
This systemic insecticide utilizes a unique physiological approach to control aphids and other sucking pests. Once ingested, it interferes with the insect's ability to feed by permanently disabling the mechanisms used to pump saliva and draw nutrients. Although the insect may remain alive for several days, it cannot feed and eventually dies. This mechanism provides highly specific and effective control.

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require continuous mixing during application because the toxicant will not settle or separate. This characteristic makes them easy to handle and provides uniform chemical distribution.

105. (B) I, II, IV and V
The legal framework for managing insecticides includes technical advice, mandatory registration, and strict enforcement of quality standards. It also specifies the consequences for legal violations and allows for the international trade of products under specific conditions. These regulations work together to balance effective pest control with the protection of human health, ensuring all products are rigorously evaluated before being sold.

106. (B) 1-Octanol and Water
This fundamental ratio measures how a chemical distributes itself between a fatty alcohol and an aqueous phase. It serves as a key indicator of lipophilicity, helping scientists predict how easily a pesticide will pass through biological membranes or accumulate in fatty tissues. Understanding this property is essential for assessing environmental behavior, biological activity, and the potential for bioaccumulation of various insecticidal compounds.

107. (A) International food standards and guidelines to protect consumer health and ensure fair trade.
This collection of internationally recognized standards and codes of practice aims to ensure global food safety. Developed by major health and agriculture organizations, it establishes maximum residue limits for pesticides in various commodities. By providing a consistent framework, it helps protect public health while facilitating the smooth trade of food products between nations, ensuring consumer access to safe goods.

108. (C) The hepatic (liver) first-pass metabolism system.
When toxic substances are inhaled, they pass directly through the lungs into the bloodstream. This route avoids the initial processing by the liver that normally occurs when chemicals are ingested. Consequently, the toxicant can reach the brain and other vital organs much faster and in a more concentrated form. This lack of early metabolic breakdown significantly increases the inhalation hazard.

109. (D) Estimated amount of pesticide in food/water ingested daily over a lifetime without appreciable health risk.
This toxicological parameter represents a safe level of exposure for humans based on long-term health data. It is derived by taking the highest dose that causes no harm in animals and dividing it by large safety factors to account for uncertainty. This ensures that even if a person is exposed every day for life, no adverse effects happen.

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110. (A) P-4, Q-3, R-1, S-2
Insect populations can evolve various ways to survive chemical treatments. Some increase their enzyme production to break down toxins, while others develop genetic changes that prevent the chemical from binding to its target. Physical changes, like a thicker cuticle, can slow down penetration. Additionally, behavioral shifts allow insects to detect and avoid treated surfaces entirely. Understanding these mechanisms is essential.

111. (B) Neuropathy Target Esterase (NTE)
Certain phosphorus-containing compounds can cause a delayed form of nerve damage separate from their immediate effect on acetylcholinesterase. This condition involves the inhibition of a specific enzyme found in the nervous system. When this protein is permanently altered by the toxicant, it leads to the degeneration of axons in peripheral nerves. This results in progressive weakness appearing several days after exposure.

112. (D) Chrysanthemic acid and Pyrethrolone
Natural pyrethrum extract consists of several active esters formed by the combination of specific acids and alcohols. The most potent component for insecticidal activity is formed from these two specific precursors. Understanding the chemical structure of these natural molecules allowed scientists to develop synthetic analogues that are more stable and effective in sunlight. This work led to modern pyrethroids.

113. (A) Higher than oral LD50 values, as the dermal barrier significantly restricts chemical absorption.
Most chemicals are less toxic when applied to the skin compared to when they are swallowed. This is because the outer layer of the skin acts as a protective shield that slows down or prevents

volatility and are not used as gaseous treatments. Their high selectivity for insect-specific processes makes them relatively safe for most vertebrates.

96. (D) To ensure residues degrade below legal ADI and MRL limits before the crop is consumed by humans.
The safety of agricultural products is maintained by requiring a specific time gap between the final pesticide treatment and the start of harvest. This interval allows natural processes to break down the chemical until its concentration falls to safe levels. By following these established periods, producers ensure that remaining residues comply with legal standards, protecting consumers from potential health risks.

97. (A) Over-expression of cytochrome P450 monooxygenases leading to rapid metabolic detoxification.
Resistance in major agricultural pests often results from an enhanced ability to metabolize toxic chemicals. By producing higher levels of specific oxidase enzymes, individuals can quickly break down insecticides like pyrethroids into harmless components. This metabolic change allows the pests to survive doses that would normally be lethal. Managing such resistance requires rotating between different chemical classes with unrelated pathways.

98. (C) 5.0
In biological assays, mortality percentages are converted into specific statistical units to create a linear model. A mortality rate of fifty percent is assigned a standard value of five. This transformation allows researchers to easily determine the median lethal dose and compare the potency of various toxicants. The system provides a consistent way to analyze the susceptibility of insect populations.

99. (A) The Food Safety and Standards Act, 2006
The national body responsible for ensuring the safety of food products in India was established under this specific legislation. It integrates several older laws to provide a single regulatory framework for food hygiene and quality. Part of its mandate involves setting maximum residue limits for pesticides in agricultural commodities, ensuring that food reaching the public meets established safety standards.

100. (C) A is true but R is false.
Phase two detoxification involves enzymes that attach endogenous molecules to toxicant intermediates. This process increases the water solubility of the chemical, making it easier for the insect to excrete it through its waste. While the first part of the statement correctly identifies the role of these transferases, the second part incorrectly suggests they create lipophilic products for storage purposes.

101. (B) DDT (and its metabolite DDE)
This persistent organochlorine is notorious for its ability to travel through the food chain and concentrate in top predators. One of its breakdown products interferes with the enzymes responsible for calcium transport in birds. This inhibition leads to the production of eggs with dangerously thin shells that break under the parent. This ecological impact was a major factor globally.

102. (B) Acute toxicity manifests within 24 hours of exposure; chronic toxicity arises from repeated exposure over time.
Toxicological risk is categorized based on the duration and frequency of contact with a chemical. The first type refers to immediate or short-term harmful effects resulting from a single high dose. The second type involves adverse health outcomes that develop gradually after multiple exposures over a long period. Both assessments are critical for establishing safety guidelines for workers and public health.

103. (D) Hydrolysis
This chemical reaction is a common pathway for the metabolic and environmental breakdown of many insecticides, especially organophosphates and carbamates. It involves the addition of a water molecule to split an ester or amide bond, resulting in smaller and usually less toxic fragments. This process is often catalyzed by specialized enzymes and plays a vital role in natural detoxification and dissipation.

104. (A) The active ingredient dissolves in water, forming a true, clear solution that requires no agitation.
Some pesticides are formulated as liquids that are completely miscible with water. When mixed, they create a transparent solution where the active ingredient is dispersed at the molecular level. Unlike other formulations, these do not

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87. (D) It is translocated via the xylem and phloem, protecting new shoots and roots throughout the plant.
Most systemic insecticides only move upward through the plant's water-conducting tissues. However, this specific compound possesses the unique ability to move in both directions, traveling through both the xylem and the nutrient-conducting phloem. This two-way transport ensures that the entire plant, including the roots and newest foliage, is protected against pests that feed on plant juices throughout development.

88. (A) Tetronic and tetramic acid derivatives, such as Spiromesifen or Spirotetramat.
These modern insecticides represent a distinct mode of action that targets the synthesis of lipids. By inhibiting a key enzyme involved in the production of fatty acids, they disrupt the development and reproduction of various pests. This mechanism is especially effective against whiteflies, scales, and mites. Because this target is different from traditional neurotoxicants, these chemicals are valuable for management.

89. (B) Pyrethroids modulate sodium channels (depolarization); avermectins activate chloride channels (hyperpolarization).
Neurotoxic insecticides often differ in how they affect the electrical state of nerve cells. One class causes persistent opening of sodium channels, leading to continuous firing and paralysis. In contrast, another class activates chloride channels, which prevents the cell from firing by making it more negatively charged. These opposite physiological effects demonstrate the diverse ways that chemicals achieve lethal toxicity.

90. (A) P-2, Q-3, R-4, S-1
Residue analysis involves several sequential laboratory techniques. Volatile compounds are separated using gas-based chromatography, while mass spectrometry allows for the precise identification of chemical structures. Preparation steps include rapid extraction and clean-up methods to remove interfering substances. Finally, vacuum systems are used to concentrate the resulting extracts by removing excess solvents. These combined tools enable trace detection of pesticides.

91. (A) Phosalone
Integrated pest management prioritizes chemicals that exhibit selectivity, protecting beneficial insects like pollinators. This specific organophosphate is notable for its relatively low toxicity to bees when applied according to safety guidelines. It provides effective control against various pests while allowing pollinators to continue their essential work. Using such selective options is a key strategy for maintaining agricultural productivity and ecological balance.

92. (C) It is chemically stable and persists in the environment for decades without degrading.
While this botanical alkaloid is extremely toxic and can be absorbed through various routes, it is not environmentally persistent. It breaks down rapidly when exposed to air and light, meaning it does not accumulate in soil or water over long periods. Historically used as a sulfate salt for pest control, its high mammalian hazard has led to replacement.

93. (D) Rapid degradation upon exposure to ultraviolet (UV) light and elevated temperatures.
Natural extracts often suffer from a lack of stability in field conditions. Many botanical insecticides lose their effectiveness within hours or days because they are quickly broken down by sunlight and heat. This short residual life requires frequent applications to maintain control, which can be costly. Improving the stability of these natural products through specialized formulations remains a major challenge.

94. (C) Buildup of a toxicant within an organism faster than it can be excreted or metabolized.
This biological process occurs when a substance is absorbed and stored in an organism's tissues more quickly than it is removed. Highly lipophilic chemicals often accumulate in fat cells, leading to increasing concentrations over time within a single individual. This internal buildup can eventually reach toxic levels, causing health problems for the organism and potentially impacting its natural predators.

95. (B) I and IV
Growth regulators differ from traditional insecticides by targeting the development of immature stages rather than causing immediate death in adults. They typically act as hormone mimics or inhibitors that disrupt molting and maturation. These chemicals generally have low

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the passage of many substances into the body. Consequently, a much larger dose is typically required to cause death through skin contact during testing.

114. (C) It activates nAChRs via an allosteric site distinctly different from the neonicotinoid binding site.
This group of natural neurotoxicants is derived from a soil bacterium and works by overstimulating the insect nervous system. They target specific receptors used for fast excitatory signals but bind to a location that is separate from other common insecticides. This unique interaction causes prolonged activation and paralysis. Because they use a different site, they are often effective against resistant pests.

115. (A) II, III, I, IV
Resistance develops through a predictable sequence when a population is under chemical stress. It begins with the presence of rare individuals that possess protective traits. When the insecticide is applied, these resistant insects survive while the susceptible ones are killed. These survivors then breed and pass on their genes to the next generation. Over time, the frequency of genes increases.

116. (D) The 'Rdl' mutation in the GABA-gated chloride channel subunit gene that reduces ligand binding.
Resistance to certain insecticides can occur when the molecular target in the nervous system is genetically modified. A specific mutation in the protein that forms inhibitory chloride channels prevents chemicals like fipronil from binding effectively. This reduced affinity means the insecticide can no longer block the channel and cause overstimulation. This mechanism provides high protection against several chemically related insecticide groups.

117. (B) Its toxicity to the target insect increases as the ambient temperature increases.
The performance of many insecticides is influenced by environmental conditions during and after application. Some chemicals become more effective as it gets warmer, a property known as having a positive temperature coefficient. This increase in lethality may be due to faster absorption, higher metabolic activation, or increased sensitivity at the target site. Understanding these relationships is vital for optimized control.

118. (C) A single population has multiple independent mechanisms, allowing survival against several insecticide classes.
This complex type of resistance occurs when an insect population possesses several different ways to survive toxic exposure simultaneously. For example, individuals might have an altered target site for one class of chemicals and enhanced metabolic enzymes for another. This differs from cross-resistance, where one mechanism protects against multiple groups. Such situations are particularly difficult to manage with simple rotation.

119. (D) Moisture facilitates desorption and release of the active ingredient from the carrier into the soil.
Granular formulations are designed to deliver active ingredients directly to the soil where pests reside. These products consist of a concentrated chemical coated onto a solid carrier like clay or sand. For the insecticide to work, it must leave the granule and move into the surrounding soil. Water is essential for this process, helping dissolve and carry the toxicant.

120. (A) Applying sublethal doses of insecticides to gradually acclimatize the pest population.
Effective resistance management programs aim to delay the development of protective traits in pests. This is achieved by rotating between different modes of action, using mixtures, and integrating non-chemical control methods. However, using low doses that do not kill the entire population is never recommended, as it actively selects for the most resistant individuals. Such practices accelerate population control failure.

121. (B) Sigmoidal (S-shaped)
When biological response is plotted against dosage, the resulting curve typically shows how sensitivity varies across a population. At very low doses, few individuals respond, while at very high doses, nearly all are affected. The middle portion of the curve represents the majority of the population with average sensitivity. This characteristic shape is common to many toxicological studies and requires transformation.

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52. (D) Malathion
This aliphatic organophosphate is notable for its selective toxicity between insects and vertebrates. It undergoes rapid detoxification in mammals through the action of carboxylesterase enzymes, which convert it into harmless metabolites. Insects, however, convert it into the highly toxic malaoxon. This biochemical difference allows the chemical to be used safely for public health and domestic purposes while remaining effective against pests.

53. (B) Limonoids (Tetranortriterpenoids)
This highly complex molecule is the primary active ingredient found in neem seeds. It belongs to a group of modified triterpenoids characterized by their diverse biological effects on insects, including growth disruption and feeding deterrence. Its intricate chemical structure makes synthetic production difficult, so it is primarily sourced through natural extraction. It is widely recognized as an effective botanical insecticide.

54. (C) Substitution at the nitrogen atom and esterification of the carboxyl group with specific organic moieties.
While the parent organic acid is not toxic, structural modifications are necessary to create effective insecticides. By adding specific organic groups to the nitrogen and forming esters, chemists create molecules that are sufficiently stable and lipophilic to pass through the insect cuticle. These changes allow the compound to reach the nervous system and inhibit acetylcholinesterase, mimicking the action of organophosphates.

55. (D) A false but R is true.
Chitin synthesis inhibitors function by disrupting the formation of the new exoskeleton during the molting process. Because adult insects have already completed their development and no longer undergo periodic molts, these chemicals have minimal impact on their survival. However, they are highly effective against larvae, where the inability to form a functional procuticle leads to death during the life stage transition.

56. (A) Ryanodine receptors (calcium channels)
This modern class of insecticides targets specific receptors located on the sarcoplasmic reticulum of muscle cells. By binding to these sites, the chemical causes the uncontrolled release of internal calcium ions, leading to muscle contraction, paralysis, and eventual death. This mechanism is highly specific to certain pest groups and exhibits an excellent safety profile for mammals with different receptor subtypes.

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57. (B) Phase I metabolism
The initial stage of detoxification involves transforming a non-polar toxicant into a more reactive intermediate. Enzymes such as cytochrome P450 monooxygenases or esterases perform reactions like oxidation or hydrolysis to add or uncover functional groups. These changes increase the molecule's polarity slightly and prepare it for the second stage of metabolism, where it will be conjugated with substances.

58. (B) Conversion of malathion to malaoxon.
Certain pesticides are applied in a relatively non-toxic form and must undergo metabolic transformation to become lethal. In this classic example, the replacement of a sulfur atom with an oxygen atom, mediated by oxidase enzymes, creates a much more potent inhibitor of acetylcholinesterase. This bioactivation is a critical step in the toxic action of several organophosphorus compounds within the nervous system.

59. (A) A secondary mutation (such as M918T) occurring in tandem with the primary kdr mutation in the sodium channel.
High levels of resistance to pyrethroids can result from multiple genetic alterations within the same target protein. While a single point mutation provides a baseline level of protection, the addition of a second mutation significantly reduces the binding affinity of the insecticide further. This combination of changes leads to extreme resistance, making even high doses of the toxicant ineffective.

60. (A) I, II and IV
Environmental fate and pesticide safety involve complex interactions between chemicals and their surroundings. A longer half-life indicates higher persistence, not lower. Photodegradation can occur on leaf surfaces or in the air, not just in soil. Additionally, the daily intake limit is expressed relative to human body weight rather than crop yield. Correcting these misconceptions is vital for risk assessments.

131. (A) They bind to specific transport proteins known as lipophorins.
In the aqueous environment of the insect body cavity, substances that do not dissolve easily in water require a specialized transport system. These large carrier proteins act as vehicles that move lipids and other non-polar compounds through the hemolymph. By binding to these proteins, lipophilic insecticides can be distributed from the point of entry to their specific target sites.

132. (D) Water Dispersible Granules (WDG)
The risk of inhaling hazardous chemicals during the preparation of spray mixtures depends heavily on the physical form of the product. Modern granular technology creates dry particles that do not produce clouds of fine dust when they are poured or measured. This lack of airborne material significantly reduces the chance of the applicator breathing in the toxicant during use.

133. (B) It occurs between insecticides sharing a common target site or metabolic degradation pathway.
This biological phenomenon occurs when an insect develops resistance to one chemical and automatically becomes resistant to others. This usually happens because the different insecticides have the same mode of action or are broken down by the same enzymes. As a result, a single genetic change can provide broad protection against multiple groups, even if they were never encountered.

134. (C) A steeper slope indicates a homogeneous population where individuals react similarly to small dose changes.
The angle of the regression line in a biological assay provides important information about how uniformly a population responds to a toxicant. A very sharp incline suggests that most individuals have a similar level of susceptibility, so a small increase in dose causes a large increase in mortality. In contrast, a flatter line indicates a diverse population with tolerances.

135. (B) I and III
These pesticides are absorbed by the plant and move through its internal plumbing to provide long-lasting protection. For this transport to happen, the chemical must be soluble enough to travel with the plant's water and nutrients. This internal movement allows the insecticide to reach and protect new parts as they grow, making it highly effective against sucking pests.

136. (A) The total observed toxicity equals the mathematical sum of the individual toxicities of the components.
When two different chemicals are mixed together, their combined effect can be predicted based on their individual potencies. In this specific type of interaction, the total mortality produced is exactly what would be expected if the chemicals were acting independently. There is no cooperation or interference between the two substances that changes the overall lethality during the application.

137. (B) Acceptable Daily Intake (ADI)
Regulatory agencies determine safe levels of chronic exposure by analyzing long-term animal studies. They identify the highest dose that causes no observable harm and then divide this value by large factors to account for uncertainty. The resulting number represents the amount of a pesticide that a person can safely consume every day for life without any health risks.

138. (B) Acetic acid and choline
The transmission of signals in the nervous system relies on chemicals that are released and then quickly removed. A specialized enzyme at the synapse performs this role by breaking down the neurotransmitter responsible for excitatory signals. This rapid reaction splits the molecule into its two component parts, which are then recycled. If this enzyme is inhibited, the signal continues.

139. (A) To distinguish between resistant and susceptible individuals in a field population sample.
Monitoring for resistance involves testing insect populations with a specific amount of a chemical that is known to kill all susceptible individuals. If any insects survive this treatment, it indicates the presence of resistance genes. This method provides a fast and reliable way to detect early signs of control failure in the field, allowing farmers to adjust their management strategies.

140. (A) P-2, Q-1, R-3, S-4
The regulation of pesticides in India involves several specialized groups and officials with distinct responsibilities. One body provides technical guidance to the government, while

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2014

44. Gossypol, a compound providing resistance against several pests in cotton, belongs to which chemical class?
(A) Terpenoids
(B) Alkaloids
(C) Glucosinolates
(D) Non-protein amino acids

2013

45. Match the secondary metabolite class (List I) with its corresponding example (List II).
List I: (Secondary Metabolite Class)
P. Alkaloids
Q. Terpenoids
R. Phenolics
S. Glucosinolates
List II: (Example)
1. Sinigrin
2. Nicotine
3. Tannins
4. Pyrethrin
(A) P-2, Q-4, R-3, S-1
(B) P-4, Q-2, R-1, S-3
(C) P-3, Q-1, R-4, S-2
(D) P-1, Q-3, R-2, S-4

2012

46. Tannins defend plants primarily by which mechanism of action?
(A) Effectively blocking specific neurotransmitter receptors within the insect's central nervous system
(B) Reducing nutrient assimilation by binding to dietary proteins and digestive enzymes
(C) Emitting extremely strong volatile signals that repel adults from the plant during the day
(D) Physically hardening the plant cuticle to prevent the insertion of mouthparts or ovipositors

2012

47. Which of the following is an INCORRECT pairing of a secondary metabolite and its typical source plant?
(A) Sinigrin - Sorghum
(B) DIMBOA - Wheat and Maize
(C) Gossypol - Cotton
(D) Tomatine - Tomato

2001

48. What is the primary role of the enzyme myrosinase in cruciferous plant defense?
(A) It acts to inhibit the insect's midgut proteases directly upon ingestion of plant tissue.
(B) It neutralizes the toxicity of specific alkaloids to protect the plant's own internal cells.
(C) It breaks down glucosinolates into toxic isothiocyanates when the plant tissue is damaged.
(D) It actively synthesizes epicuticular wax on the leaf surface to deter herbivore attack.

2021

49. In the context of host plant resistance, antixenosis specifically refers to what phenomenon?
(A) The severe physiological damage inflicted on the insect after the ingestion of toxic plant tissue.
(B) The unique ability of a plant species to grow rapidly and recover from heavy insect defoliation.
(C) The active recruitment of generalist natural enemies by the release of specific plant volatiles.
(D) Plant traits that cause an insect to select an alternative host for feeding or oviposition.

2021

50. Consider the following statements regarding antixenosis.
I. Antixenosis results in increased mortality of the insect due to toxic ingestion.
II. It can be mediated by morphological features like dense trichomes.
III. It acts during the host location and acceptance phases.
Which of the above statement(s) is/are correct?
(A) II and III
(B) I
(C) I and III
(D) II

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2021

51. A chemical compound on the plant surface that prevents an insect from continuing its feeding or oviposition behavior after contact is classified as:
(A) Repellent
(B) Deterrent
(C) Attractant
(D) Arrestant

2013

52. How does an olfactory repellent differ from a contact deterrent in mediating antixenosis?
(A) Repellents kill the insect instantly, while deterrents only slow its growth.
(B) Repellents are primary metabolites, while deterrents are secondary metabolites.
(C) Repellents operate via mechanoreceptors,

150. (C) It requires an infinite number of test subjects to derive mathematically valid statistics.
This statistical method is used to transform a curved dose-response relationship into a linear one, making it easier to calculate lethal doses. It assumes that the sensitivity of a population follows a normal distribution when the dose is measured on a logarithmic scale. While it uses complex calculations, it is designed for use with practical and limited sample sizes.

151. (D) Based on the absence (Type I) or presence (Type II) of an alpha-cyano group, causing different syndromes.
Synthetic mimics of natural pyrethrins are divided into two main categories based on a specific chemical modification. The addition of a certain nitrogen-containing group changes the way the insecticide interacts with the nervous system. This structural difference results in distinct poisoning symptoms in insects, such as tremors versus twisting movements. Understanding these categories is important for the effective chemical application.

152. (A) It signifies high affinity for soil organic carbon, indicating low potential for leaching into groundwater.
This environmental parameter measures how strongly a pesticide binds to the organic matter in the soil. A high value suggests that the chemical is likely to stay where it is applied rather than moving with water through the soil profile. This reduced movement lowers the risk of reaching groundwater. Assessing this property is critical for determining overall environmental risk.

153. (B) The Stockholm Convention
This international agreement was established to protect humans and the ecosystem from chemicals that stay in the environment for a long time. It focuses on substances that can travel long distances, accumulate in food chains, and cause harmful effects. Many older pesticides that were once widely used are now strictly controlled or banned under this specific coordinate global action.

154. (B) Carboxylesterases (Aliesterases)
The safety of this particular insecticide in vertebrates is due to a specific metabolic advantage. Mammals have high levels of these enzymes, which can quickly break down the toxicant into harmless fragments. Insects have much lower levels of this protective pathway and instead convert the chemical into a more toxic form. This difference allows the pesticide to be used safely.

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155. (A) If its label contains any statement, design, or graphic relating to the insecticide which is false or misleading.
According to national pesticide laws, a product is considered to be improperly labeled if the information on its container is inaccurate or deceptive. This includes any claims about its effectiveness, safety, or ingredients that do not match the facts. Ensuring that all information is truthful is vital for protecting users. This regulation helps prevent the sale of poor-quality chemicals.

156. (C) Organophosphates and Carbamates
Resistance can occur when the specific protein targeted by an insecticide is modified. Because these two chemical groups both inhibit the same enzyme in the nervous system, a single genetic change in that enzyme can provide protection against both. This type of target-site resistance is a common problem in pest populations that have been exposed to these chemicals over time.

157. (D) Allowing time for residues to degrade naturally to non-toxic levels before the crop is harvested.
This management strategy involves waiting for a specific period after the last pesticide application before starting the harvest. During this time, the chemical is broken down by sunlight, moisture, and microbes until its concentration is below safe limits. Following this schedule ensures that agricultural products reaching consumers do not contain excessive amounts of chemicals and meet safety standards.

158. (C) Flame Photometric Detector (FPD) in phosphorus mode
In residue analysis, specialized tools are used to detect specific elements within a chemical mixture. This detector is highly sensitive to light emitted by phosphorus atoms when they are burned in a flame. By filtering for this specific wavelength, laboratories can identify and measure organophosphorus pesticides with high precision, even when they are present in very small trace amounts.

159. (B) To inhibit detoxification enzymes (P450s/ Esterases), helping identify the resistance mechanism.
These chemicals are used in laboratory tests to figure out why an insect population is no longer dying from a treatment. By adding a substance that blocks specific enzymes, researchers can see if the toxicity of the pesticide returns to normal levels. If it does, it suggests that the insects were surviving by overproducing those enzymes to break down chemicals.

160. (A) Extremely hazardous
International health organizations use a specific classification system to rank pesticides based on their potential for harm. The most dangerous category is reserved for substances with a very low lethal dose, meaning only a tiny amount is needed to cause death. Chemicals in this group require the strictest regulations and safety measures for their handling, storage, and the final application.

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CHAPTER 07
Host Plant Resistance

2015

1. Which of the following best defines the concept of host plant resistance as formalized in agricultural entomology?
(A) The complete immunity of a plant species to all herbivorous insects present in a given ecosystem and climate
(B) The temporary reduction in pest damage due to environmental factors such as temperature or soil nutrient levels
(C) The periodic use of chemical applications to suppress insect populations below the estimated economic injury level
(D) The heritable qualities of a plant that determine the degree of damage sustained from specific insect pests

2009

2. In the classification of host plant resistance mechanisms, which of the following is defined as the adverse effect of the plant on the biology of the insect?
(A) Tolerance
(B) Antixenosis
(C) Antibiosis
(D) Pseudoresistance

2022

3. Which of the following statements regarding the categorization and historical development of host plant resistance is INCORRECT?
(A) A foundational categorization established resistance into non-preference, antibiosis, and tolerance.
(B) Resistance has been proved to be strictly dependent on vertical gene deployment.
(C) Key milestones established that host plant resistance is a heritable characteristic.
(D) Early research proved the existence of specific mechanisms that deter insect feeding.

2007

4. In evaluating the utility of host plant resistance, which is considered its most relevant advantage in integrated pest management?
(A) It permanently eradicates local pest populations within a single commercial cropping season.
(B) It functions as a standalone tactic that requires no other cultural or biological management practices.
(C) It rapidly alters the existing soil microbiome to actively deter various types of pupating insects.
(D) It is compatible with other control tactics and continuously cumulative over successive seasons.

2016

5. Consider the following statements regarding the historical milestones in host plant resistance.
I. The Hessian fly resistance in wheat was an early successful example of host plant resistance.
II. The term 'non-preference' was later replaced by the term 'antixenosis' in 1978.
III. Tolerance does not actively suppress the insect population.
Which of the above statement(s) is/are correct?
(A) I and III
(B) II
(C) II and III
(D) I

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2008

6. A phenomenon where a susceptible plant escapes insect injury due to early maturation is an example of which concept?
(A) Genetic tolerance
(B) True resistance
(C) Host evasion
(D) Induced antibiosis

2016

7. The primary electrophysiological technique used to record action potentials from insect chemosensilla in response to plant volatiles is known as what?
(A) Electroantennography
(B) Gas chromatography
(C) Mass spectrometry
(D) High-performance liquid chromatography

another focuses on the review of safety and efficacy data for registration. A dedicated laboratory performs the testing of field samples to ensure quality, and inspectors are tasked with enforcing the law and sampling.

141. (D) Increased synthesis/activity of detoxification enzymes triggered by sublethal exposure to xenobiotics.
Insects can adapt to the presence of toxic chemicals by ramping up their internal defenses. When exposed to small amounts of a substance that do not cause death, the insect's body may respond by producing more of the enzymes used to break down the toxicant. This increased activity makes the individual better able to survive future exposures and leads to resistance.

142. (C) The carbamylated enzyme undergoes spontaneous reactivation much faster than a phosphorylated one.
Although both chemical groups inhibit the same vital enzyme in the nervous system, they differ in how long the inhibition lasts. When this specific class of pesticides binds to the enzyme, the bond is relatively unstable and can break down on its own after a short time. This allows the enzyme to return to its normal function much more quickly.

143. (B) Limit of Quantification (LOQ)
In analytical chemistry, there is a difference between detecting a substance and being able to measure it accurately. While a detector might show that a pesticide is present at very low levels, it must reach a certain threshold before the amount can be precisely reported with confidence. This threshold is used by laboratories to define the smallest concentration reliably measured.

144. (D) Photochemical degradation (photolysis) induced by ultraviolet radiation.
The breakdown of many modern insecticides in the environment is driven by energy from the sun. When these chemicals are exposed to sunlight on leaf surfaces or in the soil, the ultraviolet rays can break their chemical bonds, leading to the formation of smaller, non-toxic products. This process is a major pathway for natural dissipation after the pesticide application.

145. (A) III, II, IV, I
Modern laboratory testing for pesticide residues follows a streamlined sequence of preparation and analysis. The process starts with grinding the sample to ensure it is uniform, followed by the addition of a solvent to pull out the chemicals. Specific salts are then used to separate the different liquid phases. Finally, a clean-up step removes impurities that might interfere with results.

146. (C) Cyclodienes
This group of legacy organochlorine insecticides is characterized by a specific cyclic structure and was once widely used for pest control. They are notorious for being highly toxic to mammals and for their ability to persist in the environment for long periods. Because of these hazards and their tendency to build up in the food chain, they are strictly restricted.

147. (A) -OH, -COOH, -NH2, or -SH
The initial stage of metabolism focuses on making a toxicant more reactive and polar. This is achieved by adding or exposing specific chemical groups through reactions like oxidation or hydrolysis. These changes create a handle that allows other enzymes to attach larger molecules in the next stage. This process is essential for transforming fat-soluble pesticides into forms easily excreted.

148. (D) The vapor pressure of the insecticidal compound at ambient temperature.
For a gaseous pesticide to be effective, it must be able to move through the air and enter the insect's respiratory system. The ease with which a liquid or solid turns into a gas at a given temperature is a critical factor in its performance. Chemicals with high values for this property can quickly fill a space and penetrate openings.

149. (B) It enhances detoxification enzyme expression (e.g., GSTs or P450s) in the crop but not the pest.
These additives work by specifically boosting the internal defenses of the treated plants. When applied, they trigger the production of more enzymes that can break down the pesticide before it causes harm to the crop tissues. Crucially, this effect is selective and does not happen in the target insects, which remain susceptible to the toxicant throughout the entire process.

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(C) Wind currents and phototactic responses
(D) Density of trichomes on the stem

2003

17. The transition from host location to host recognition is critically dependent upon which insect behavior?
(A) Courtship and mating displays
(B) Molting to the next instar
(C) Dropping to the soil to pupate
(D) Arrestment and localized exploration of the plant surface

2019

18. Which biological mechanism often dictates the ultimate acceptance of a plant for oviposition?
(A) The perception of systemic acquired resistance signals by the adult female insect
(B) The visual identification of adjacent non-host plants to avoid competition for resources
(C) The detection of specific token stimuli or kairomones present on the leaf surface
(D) The avoidance of horizontally deployed resistance genes within a mixed cropping system

2014

19. An insect consistently lands on a plant but immediately flies away without probing. This behavior indicates a disruption at which phase?
(A) Habitat location
(B) Host recognition and acceptance
(C) Oviposition
(D) Digestive absorption

2006

20. Select the correct sequence of phases in insect host plant selection.
(A) Host recognition → Habitat location → Host location → Acceptance
(B) Habitat location → Host location → Host recognition → Acceptance
(C) Host location → Habitat location → Acceptance → Host recognition
(D) Acceptance → Host location → Host recognition → Habitat location

2010

21. Which of the following is NOT a recognized category of ecological resistance (pseudoresistance)?
(A) True antibiosis
(B) Host evasion
(C) Host escape
(D) Induced temporary resistance

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2021

22. What characterizes host escape in the context of ecological resistance?
(A) The plant produces specific phytochemical toxins that actively reduce the survival rate of larvae
(B) The plant completes its susceptible growth stage before the peak of the local pest population
(C) Unequal pest distribution that leaves some susceptible individual plants randomly uninfested
(D) The plant recovers from insect damage by producing compensatory tillers following an infestation

2005

23. Environmentally induced temporary resistance is most likely caused by which of the following?
(A) Variations in soil moisture and nutrient availability affecting the plant's sap composition
(B) A constitutive genetic mutation altering the density of trichomes on the leaf surface
(C) The strategic horizontal deployment of major resistance genes within a diverse landscape
(D) The natural selection of a new insect biotype that is capable of overcoming chemical defenses

2007

24. A rice variety planted early in the season escapes gall midge damage because the pest emerges a month later. This is an example of what mechanism?
(A) Antibiosis
(B) Antixenosis
(C) Morphological tolerance
(D) Host evasion

2001

25. Consider the following statements concerning pseudoresistance.
I. Pseudoresistance is under strict monogenic genetic control.
II. Host evasion is a form of pseudoresistance utilized in cultural pest control.
III. Environmental factors cannot modify a plant's temporary resistance level.
IV. Host escape occurs when the insect simply fails to find the susceptible plant.
Which of the above statement(s) is/are INCORRECT?
(A) I, II and IV
(B) II and IV

(C) I, III and IV
(D) I and III

2019

26. In an experiment, high nitrogen fertilizer application eliminates a plant's resistance to aphids. What does this suggest about the resistance?
(A) It is a permanent vertical resistance trait.
(B) It is solely dependent on a single major gene.
(C) It is a form of environmentally induced temporary resistance.
(D) It operates via strong morphological barriers like silica.

2010

27. How does the application of pseudoresistance concepts benefit agricultural practices?
(A) By completely replacing the need to breed genetically resistant varieties
(B) By increasing the rate of biotype evolution
(C) By destroying the natural enemy populations
(D) By informing optimal planting dates to achieve host evasion

2014

28. Which of the following physical plant defenses acts primarily by trapping small insects or restricting their movement?
(A) Glandular and non-glandular trichomes
(B) Phloem sap viscosity
(C) Intracellular silica deposition
(D) Epicuticular wax composition

2010

29. The excessive deposition of silica in rice leaf epidermal cells primarily confers resistance against which pest?
(A) Rice hispa
(B) Yellow stem borer
(C) Brown planthopper
(D) Rice water weevil

2004

30. Given below are structural layers of a typical plant leaf surface.
I. Epidermal cell wall
II. Epicuticular wax
III. Cutin layer
IV. Mesophyll cells
Which of the following is the correct sequence of layers from the outermost to the innermost as encountered by an insect?
(A) II, III, I, IV
(B) I, II, III, IV
(C) III, II, I, IV
(D) II, I, III, IV

2021

31. Solid stems in specific wheat varieties present a physical barrier that provides effective resistance against which insect?
(A) Wheat stem sawfly
(B) Greenbug
(C) Hessian fly
(D) Russian wheat aphid

2002

32. Which physical trait frequently reduces the efficiency of insect tarsal adhesion, causing them to fall off the plant?
(A) Increased tissue thickness
(B) Lignified vascular bundles
(C) Highly crystalline epicuticular wax blooms
(D) Solid stem pith

2001

33. The thickness of plant tissue, such as a thick pod wall in chickpea, functions as a defense by which mechanism?
(A) Rapidly poisoning the larval digestive system using localized secondary metabolites
(B) Emitting toxic volatiles that repel adults from the plant surface before landing occurs
(C) Attracting generalist parasitoid wasps to the site through the release of specific volatiles
(D) Preventing the insect ovipositor from reaching and damaging the developing seeds

2018

34. How do glandular trichomes differ functionally from non-glandular trichomes in host plant resistance?
(A) Glandular trichomes act only as physical obstacles, whereas non-glandular variants secrete various toxins.
(B) Glandular trichomes are located strictly on the roots, whereas non-glandular variants are leaf-bound.
(C) Glandular types secrete exudates with allelochemicals, providing both physical and chemical defense.
(D) Glandular trichomes specifically inhibit the process of host evasion by slowing down insect movement.

2023

35. Consider the following statements about physical plant defenses.
I. Silica reduces the digestibility of plant tissues for herbivores.
II. Trichomes can entrap small insects and

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impede movement.
III. Solid stems in wheat deter the wheat stem sawfly.
IV. Thick plant cell walls can deter stylet penetration by aphids.
V. Epicuticular waxes only serve to attract herbivores.
Which of the above statement(s) is/are correct?
(A) I, II, III and IV
(B) I, III and V
(C) II, III, IV and V
(D) I, II and IV

2025

36. An allelochemical that is emitted by a plant and evokes a behavioral or physiological response that is adaptive to the receiving insect but not the emitting plant is called what?
(A) Allomone
(B) Synomone
(C) Pheromone
(D) Kairomone

2015

37. Which statement correctly describes the function of an allomone?
(A) It provides an adaptive advantage to the emitter but not the receiver.
(B) It benefits both the emitter and the receiver.
(C) It provides an adaptive advantage to the receiver but not the emitter.
(D) It mediates communication strictly between individuals of the same species.

2012

38. A volatile compound released by a plant that attracts both a herbivore and the herbivore's natural enemy functions ecologically as what?
(A) Solely an allomone
(B) Solely a kairomone
(C) A synomone and a kairomone depending on the receiver
(D) An apneumone

2024

39. Which of the following examples best illustrates the action of a synomone?
(A) A floral scent that attracts a pollinating insect
(B) A toxin that kills a feeding caterpillar
(C) A chemical that attracts a pest to its host plant
(D) A repellent that deters an aphid from landing

2019

40. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Kairomones emitted by crops can increase their vulnerability to specific insect pests.
Reason (R): Kairomones mediate responses that provide an adaptive advantage exclusively to the emitting plant.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2012

41. Glucosinolates in cruciferous plants act as toxins to many generalist herbivores but stimulate feeding in the cabbage butterfly. In relation to the cabbage butterfly, glucosinolates act as what?
(A) Allomones
(B) Kairomones
(C) Repellents
(D) Synomones

NODIA

2019

42. Secondary plant metabolites differ from primary metabolites primarily in what way?
(A) They are directly involved in the fundamental metabolic processes of photosynthesis and respiration.
(B) They are ubiquitous across all plant species and are found in nearly identical concentrations.
(C) They are not essential for basic growth but mediate ecological interactions and defense.
(D) They consist exclusively of high molecular weight proteins synthesized during the reproductive stage.

2001

43. Which of the following constitutes a major class of nitrogen-containing secondary plant metabolites known for their toxicity to insect nervous systems?
(A) Terpenoids
(B) Phenolics
(C) Flavonoids
(D) Alkaloids

2018

8. In the insect sensory system, what is the specific biological role of mechanoreceptors?
(A) Detecting specific volatile plant compounds over relatively long distances within the canopy
(B) Recognizing dissolved sugars and amino acids upon contact with the plant's internal vascular tissue
(C) Triggering the release of systemic acquired resistance in the plant following an initial herbivore attack
(D) Sensing physical plant attributes such as trichome density and surface texture during exploration

2001

9. Which structural feature differentiates a typical insect olfactory sensillum from a mechanosensillum?
(A) Presence of a single apical pore
(B) Presence of multiple pores along the setal shaft
(C) Complete absence of dendrites
(D) An inflexible basal socket structure

2003

10. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Contact chemoreceptors on an insect's tarsi are crucial for the final decision to accept or reject a host plant.
Reason (R): These receptors detect non-volatile primary and secondary metabolites present on the plant surface.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2007

11. Which type of sensilla is primarily responsible for perceiving volatile cues emitted by host plants during habitat location?
(A) Sensilla trichodea
(B) Sensilla basiconica
(C) Sensilla campaniformia
(D) Sensilla styloconica

2001

12. Damage to the sensilla styloconica on the maxillary palps of a lepidopteran larva will most directly disrupt which phase of host selection?
(A) Gustatory assessment and feeding continuation
(B) Long-range habitat location
(C) Short-range visual orientation
(D) Initial physical landing on the plant

2022

13. Which statement identifies a common misunderstanding about insect visual sensory inputs during host plant selection?
(A) Visual cues such as plant shape and color contrast are often integrated with olfactory cues.
(B) Insects utilize visual cues to locate hosts only after olfactory cues are exhausted.
(C) Photoreceptors in the compound eye facilitate short-range orientation.
(D) Spectral reflectance of foliage assists in discriminating host suitability.

2003

14. What sequential behavioral response typically follows successful host recognition by an insect?
(A) Habitat location
(B) Host acceptance and sustained feeding or oviposition
(C) Evasion of natural enemies
(D) Diapause initiation

2011

15. Match the following phases of host plant selection (List I) with their primary insect sensory modality or action (List II).
List I: (Phase)
P. Habitat location
Q. Host location
R. Host recognition
S. Oviposition
List II: (Sensory Modality/Action)
1. Contact chemoreception
2. Long-range olfaction and vision
3. Short-range directed flight
4. Assessment of plant physical texture
(A) P-2, Q-3, R-1, S-4
(B) P-3, Q-2, R-4, S-1
(C) P-1, Q-4, R-2, S-3
(D) P-2, Q-1, R-3, S-4

2021

16. During the initial phase of habitat location, which environmental factor most strongly influences the dispersing insect?
(A) Cuticular wax composition of the target leaf
(B) Concentration of specific alkaloid toxins in the phloem

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while deterrents operate via photoreceptors.
(D) Repellents act at a distance via volatiles, while deterrents require physical contact.

2001

53. If a plant exhibits strong antixenosis against oviposition, what is the most likely consequence for the pest population in a monoculture field?
(A) Adults may lay eggs on the resistant crop at reduced rates if no alternative hosts exist.
(B) The pest population will undergo rapid morphological mutations to consume different tissues.
(C) The eggs laid on the crop will suffer total mortality due to the presence of systemic toxins.
(D) The host plant will immediately initiate a compensatory tillering response to the pest presence.

2011

54. The application of antixenosis is sometimes considered risky in large continuous monocultures because:
(A) The pests will instantly evolve cross-resistance to biological control agents.
(B) The trait relies entirely on non-heritable environmental factors.
(C) Denied alternative hosts, pests may eventually accept the resistant variety.
(D) It causes extreme stunting in the host plant itself.

2025

55. Consider the following physiological impacts resulting from antibiosis in host plants.
I. Increased juvenile mortality
II. Reduced adult fecundity
III. Prolonged developmental time
IV. Instantaneous avoidance behavior before feeding
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, III and IV
(C) I, II and III
(D) II and IV

2025

56. Which of the following defines antibiosis?
(A) Disruption of insect behavioral responses leading to host rejection.
(B) The ability of a plant to sustain high yield despite severe insect injury.
(C) The emission of volatile signals to attract parasitoids.
(D) Plant traits that negatively impact the biology, growth, and reproduction of an insect.

2011

57. Protease inhibitors in legume seeds confer antibiosis primarily by doing what?
(A) Disrupting the insect's nervous system conduction
(B) Binding to and inhibiting digestive enzymes in the insect midgut
(C) Preventing the insect from detecting the seed's odor
(D) Hardening the seed coat to prevent mechanical entry

2018

58. Nutritional imbalance can function as an antibiosis mechanism when a plant:
(A) Accumulates high levels of defensive alkaloids
(B) Deflects the ovipositor due to heavy tissue lignification
(C) Lacks essential amino acids or vitamins required by the feeding insect
(D) Produces excessive amounts of sucrose in the phloem

2018

59. A significant prolongation of the larval developmental period due to antibiosis provides what ecological advantage?
(A) It increases the probability of the larvae mutating into a new biotype.
(B) It ensures the insect reaches a larger final body mass.
(C) It prevents the plant from utilizing the salicylic acid pathway.
(D) It extends the window of vulnerability of the larvae to natural enemies and weather.

2023

60. Consider the following statements concerning antibiosis.
I. Antibiosis requires the insect to ingest plant material.
II. It never exerts selection pressure for the development of insect biotypes.
III. Certain chemical compounds in corn cause antibiosis against the European corn borer.
IV. It only affects the adult stage of the insect.
V. Toxins and digestibility reducers are common mediators of antibiosis.
Which of the above statement(s) is/are correct?
(A) II, III, IV and V
(B) I, II and IV

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2005

94. A farming region notices that their previously resistant rice cultivar is suffering 80% damage from the brown planthopper. What is the most appropriate immediate remedial measure?
(A) Switch to a cultivar with a different major Bph resistance gene
(B) Increase nitrogen fertilizer to boost plant tolerance
(C) Plant the exact same cultivar but twice as densely
(D) Wait for the pest to naturally lose its virulence mutation

2008

95. Consider the following statements concerning the genetics of host plant resistance.
I. Vertical resistance is usually controlled by a single major gene.
II. Horizontal resistance provides protection against a broad spectrum of biotypes.
III. Vertical resistance is more stable over long time periods than horizontal resistance.
IV. Horizontal resistance is typically polygenic in nature.
V. The gene-for-gene hypothesis primarily applies to horizontal resistance.
Which of the above statement(s) is/are correct?
(A) I, II, III and V
(B) I, II and IV
(C) II, III, IV and V
(D) I, III and V

2025

96. Which statement accurately describes vertical resistance?
(A) It is race-non-specific and governed by many genes.
(B) It provides a moderate level of tolerance to all known insect herbivores.
(C) It confers a high level of resistance against specific pest biotypes but is vulnerable to rapid breakdown.
(D) It is an environmentally induced form of pseudoresistance.

2015

97. Which of the following is an INCORRECT characterization of horizontal resistance?
(A) It is generally race-non-specific.
(B) It is usually governed by multiple minor genes.
(C) It is considered more durable and stable over time.
(D) It exerts intense selection pressure resulting in rapid biotype evolution.

2025

98. A race-specific resistance trait is most likely to exhibit which inheritance pattern?
(A) Strictly polygenic
(B) Maternal inheritance only
(C) Monogenic or oligogenic
(D) Epigenetic silencing

2017

99. The concept of "race-non-specific" resistance implies that the plant:
(A) Defends equally poorly against all insects.
(B) Employs a broad, generalized defense mechanism effective against multiple biotypes of a pest.
(C) Lacks any heritable genetic defense traits.
(D) Only relies on physical barriers like silica.

NODIA

2011

100. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Cultivars relying exclusively on a single major gene for resistance frequently experience a "boom and bust" cycle.
Reason (R): The high selection pressure rapidly selects for virulent insect biotypes that overcome the resistance, rendering the cultivar obsolete.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2007

101. When breeding a crop for a region with a history of rapid biotype evolution, which genetic strategy should a breeder prioritize?
(A) Selecting for horizontal resistance or pyramiding multiple vertical genes
(B) Deploying a single dominant vertical resistance gene
(C) Maximizing the accumulation of primary metabolites
(D) Eliminating all morphological defense structures

2017

102. Monogenic resistance is defined as resistance controlled by:
(A) Multiple interacting genes with additive effects
(B) Exactly two genes

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(D) Plant, herbivorous insect, and the natural enemy of the herbivore

2009

69. Herbivore-induced plant volatiles (HIPVs) are crucial in tritrophic interactions because they:
(A) Act as specific signals that recruit parasitoids or predators to the infested host plant.
(B) Deter pollinators from visiting flowers that are currently suffering from chewing damage.
(C) Immediately seal the various wounds caused by the mouthparts of chewing insect pests.
(D) Induce rapid flowering in adjacent uninjured plants to ensure reproductive success.

2011

70. Match the following volatile signaling concepts (List I) with their descriptions (List II).
List I: (Volatile Signaling Concept)
P. Constitutive volatiles
Q. HIPVs
R. Green leaf volatiles (GLVs)
S. Systemic emission
List II: (Description)
1. Volatiles emitted specifically in response to herbivore feeding damage
2. Rapidly released six-carbon alcohols/ aldehydes from physically broken plant cells
3. Volatiles released from uninjured parts of a plant undergoing localized herbivory
4. Baseline volatile emissions from an undamaged plant
(A) P-4, Q-1, R-2, S-3
(B) P-4, Q-1, R-2, S-3
(C) P-1, Q-4, R-3, S-2
(D) P-3, Q-2, R-4, S-1

2016

71. The specificity of HIPV blends is often determined by what factor?
(A) The specific elicitors present in the insect's oral secretions
(B) The color of the plant's flowers
(C) The amount of epicuticular wax on the leaves
(D) The baseline level of nitrogen in the soil

2016

72. Which agricultural practice could most directly disrupt the protective function of HIPVs?
(A) Planting complex polycultures instead of simplified commercial monocultures
(B) Implementing intensive biological control augmentation in greenhouse systems
(C) Use of modern drip irrigation systems to deliver water and nutrients
(D) Use of broad-spectrum insecticides that eliminate local natural enemy populations

2018

73. Which of the following compounds is generally NOT classified as an induced plant volatile functioning in tritrophic defense?
(A) Indole
(B) Cellulose
(C) Linalool
(D) Methyl salicylate

2021

74. The interaction between plants emitting HIPVs and the parasitoids that respond to them is best described ecologically as:
(A) Amensalism
(B) Competitive exclusion
(C) Mutualism
(D) Commensalism

2010

75. Select the correct general sequence of events leading to Systemic Acquired Resistance (SAR).
(A) Local infection → Salicylic acid accumulation → Pathogenesis-related (PR) protein synthesis → Systemic protection
(B) Systemic protection → PR protein synthesis → Salicylic acid accumulation → Local infection
(C) Salicylic acid accumulation → Local infection → Systemic protection → PR protein synthesis
(D) PR protein synthesis → Local infection → Systemic protection → Salicylic acid accumulation

2010

76. In the context of induced resistance, what is an elicitor?
(A) A molecule from the pest or pathogen that is recognized by the plant, triggering defense responses
(B) A plant enzyme that degrades insect mandibles
(C) A synthetic pesticide applied to leaves
(D) A regulatory protein that inhibits jasmonic acid synthesis

2017

77. How does Induced Systemic Resistance (ISR) primarily differ from Systemic Acquired Resistance (SAR)?
(A) ISR relies exclusively on salicylic acid, whereas SAR relies on jasmonic acid.

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immediately excrete the intact protein via the respiratory system.
(C) Toxicity requires specific midgut receptors and alkaline conditions that are absent in humans.
(D) The Cry proteins require prolonged exposure to high-intensity UV light for their final activation.

2017

129. Pyramiding a Cry gene and a Vip gene in a single transgenic crop variety is primarily done to:
(A) Increase the crop's drought tolerance.
(B) Enhance the nutritional flavor of the crop for human consumption.
(C) Decrease the cost of seed production.
(D) Delay the evolution of insect resistance by targeting two different midgut receptors simultaneously.

2009

130. RNA interference (RNAi) as an advanced tool in host plant resistance is based on the plant expressing:
(A) Synthetic delta-endotoxins
(B) Large quantities of toxic secondary metabolites
(C) Double-stranded RNA (dsRNA) complementary to a vital insect gene
(D) Physical barriers like increased epicuticular wax

2014

131. Upon ingestion of the plant-derived dsRNA, the insect's cellular machinery processes it into:
(A) Transfer RNAs (tRNAs)
(B) Small interfering RNAs (siRNAs) that guide the degradation of the target messenger RNA (mRNA)
(C) Ribosomal RNAs (rRNAs)
(D) DNA polymerase enzymes

2009

132. The ultimate mechanism of mortality or stunting caused by RNAi in target insects is:
(A) Massive pore formation in the midgut
(B) Nutritional starvation due to blocked mouthparts
(C) The overproduction of juvenile hormone
(D) The post-transcriptional silencing of genes essential for insect survival or development

2016

133. Marker-Assisted Selection (MAS) significantly accelerates the breeding of resistant varieties by:
(A) Allowing selection of resistance traits based on linked DNA markers rather than relying solely on phenotypic pest screening.
(B) Directly injecting target genes into the embryo.
(C) Eliminating the need to ever backcross the plant.
(D) Mutating the plant genome at specific marker loci.

2002

134. Which of the following statements about Marker-Assisted Selection (MAS) is FALSE?
(A) It requires the identification of molecular markers tightly linked to the resistance gene.
(B) It is highly effective for pyramiding multiple genes with similar phenotypic effects.
(C) It replaces the need for any final phenotypic field testing before commercial release.
(D) It can be utilized at the seedling stage before the plant reaches a susceptible growth phase.

2008

135. In a MAS backcrossing program, what is the purpose of 'foreground selection'?
(A) To confirm the presence of the specific target resistance gene(s) from the donor parent
(B) To randomly scan the genome for uncharacterized mutations
(C) To recover the genetic background of the recurrent parent
(D) To select plants with the tallest physical height

2025

136. Quantitative Trait Loci (QTL) mapping is fundamentally used to:
(A) Identify the chromosomal regions that contribute to a complex, polygenically inherited resistance trait.
(B) Synthesize new Bt toxins in the laboratory.
(C) Map the geographic spread of an insect pest.
(D) Determine the molecular weight of secondary metabolites.

2025

137. Altered receptor binding is a primary mechanism by which insects develop resistance to transgenic Bt crops. This involves:
(A) The insect overproducing digestive proteases to degrade the plant faster.
(B) A mutation modifying the midgut epithelial proteins so the Cry toxin can no longer bind.
(C) The insect learning to visually avoid transgenic plants.
(D) The plant shutting down the expression of

NODIA

2021

86. The Asian rice gall midge (Orseolia oryzae) is notorious for:
(A) Its inherent inability to evolve into various biotypes despite environmental pressures.
(B) Overcoming the resistance mechanisms of Bt cotton through dietary adaptation.
(C) Developing multiple regional biotypes that vary in their response to specific Gm genes.
(D) Being managed exclusively through the use of tolerance mechanisms within wheat varieties.

2003

87. Under the gene-for-gene concept in plant-insect interactions, what specific relationship dictates survival?
(A) A plant resistance gene (R) is overcome by an insect virulence gene (v).
(B) A plant susceptibility gene prevents insect feeding.
(C) Plant tolerance genes mutate the insect's avirulence genes.
(D) Minor plant genes create synergistic toxicity.

2003

88. When screening diverse rice accessions to characterize a suspected new gall midge biotype, what is the standard biological material utilized?
(A) A random mixture of commercial susceptible varieties
(B) Artificial diet lacking essential amino acids
(C) Purified secondary plant metabolites in a petri dish
(D) A set of standardized differential host varieties with known resistance genes

2004

89. In managing insect biotypes, the strategy of 'gene deployment' refers to:
(A) The random mutation of plant genomes using radiation
(B) The strategic spatiotemporal allocation of specific resistance genes in crop varieties to delay biotype selection
(C) Transferring genes from insects into plant genomes
(D) Relying entirely on pseudoresistance

2002

90. Consider the following statements regarding biotype management strategies.
I. Spatial rotation involves planting different resistance genes in adjacent geographic areas.
II. Temporal rotation involves using the same resistance gene continuously for decades.
III. Gene pyramiding incorporates multiple major resistance genes into a single cultivar.
IV. Sequential release provides new genes only after the previous gene has been overcome.
Which of the above statement(s) is/are INCORRECT?
(A) I and III
(B) I, III and IV
(C) II and IV
(D) II

2003

91. Which approach describes spatial gene deployment?
(A) Alternating resistant and susceptible varieties in successive seasons
(B) Stacking multiple resistance genes in the exact same plant genome
(C) Applying insecticides selectively to field margins
(D) Growing varieties with different resistance genes in different distinct geographical zones

2013

92. Temporal rotation of resistance genes aims to achieve what specific outcome?
(A) Altering selection pressure between seasons to prevent a biotype from fixing in the population.
(B) Exposing the insect population to a constant and predictable selection pressure over many years.
(C) Inducing temporary pseudoresistance via the natural variation of local climatic conditions.
(D) Increasing the total nutritional value and commercial appeal of the crop for human consumption.

2023

93. Gene pyramiding is often considered superior to the sequential release of single genes because:
(A) It entirely eliminates the need for any other cultural or biological integrated pest management practices.
(B) Insects must simultaneously acquire multiple virulence mutations, which is statistically improbable.
(C) It allows the plant to use the mechanism of host evasion more efficiently during the seedling stage.
(D) It restricts the expression of resistance to a single specific developmental stage of the host plant.

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(B) ISR is typically triggered by beneficial soil microbes, whereas SAR is triggered by localized pathogen infection.
(C) ISR only provides local defense, whereas SAR protects the entire plant.
(D) ISR is a constitutive defense, whereas SAR is inducible.

2002

78. Which phytohormone pathway is primarily activated in response to chewing insects and necrotrophic pathogens?
(A) Salicylic acid pathway
(B) Jasmonic acid pathway
(C) Gibberellic acid pathway
(D) Abscisic acid pathway

2004

79. The salicylic acid pathway is generally most effective against which type of attackers?
(A) Biotrophic pathogens and piercing-sucking insects like aphids
(B) Chewing caterpillars
(C) Root-knot nematodes
(D) Leaf-mining flies

2016

80. Given below are steps involved in the jasmonate signaling pathway following herbivore attack.
I. Release of linolenic acid from chloroplast membranes
II. Herbivore damage and elicitor recognition
III. Activation of defense gene expression (e.g., protease inhibitors)
IV. Biosynthesis of Jasmonic Acid (JA)
Which of the following is the correct sequence of these steps?
(A) II, I, IV, III
(B) I, II, III, IV
(C) II, IV, I, III
(D) IV, II, I, III

2002

81. The phenomenon where the activation of the salicylic acid pathway suppresses the jasmonic acid pathway is known as what?
(A) Synergistic induction
(B) Epigenetic silencing
(C) Constitutive dominance
(D) Phytohormonal crosstalk

2009

82. Which of the following provides the most precise definition of an insect biotype in the context of host plant resistance?
(A) A distinct new species of insect that evolves after prolonged exposure to chemical pesticides.
(B) A population of insects that possess visible morphological differences from the standard wild type.
(C) An insect population that differs in its ability to utilize a specific resistant variety.
(D) A small subset of the total plant population that lacks the required major resistance genes.

NODIA

2022

83. The genetic basis of a newly evolved insect biotype is typically linked to:
(A) The loss of visual acuity in the adult stage
(B) Allelic changes that overcome specific plant resistance genes (often gene-for-gene interaction)
(C) The rapid horizontal transfer of genes from the host plant to the insect
(D) Environmentally induced phenotypic plasticity

2004

84. What is the primary evolutionary driver causing the rapid emergence of new insect biotypes in agricultural systems?
(A) The application of broad-spectrum contact insecticides.
(B) The integration of mechanical harvesting techniques.
(C) The use of multiple minor resistance genes (horizontal resistance).
(D) Widespread and continuous planting of crop varieties with a single major resistance gene (vertical resistance).

2024

85. Consider the following statements concerning Nilaparvata lugens (Brown Planthopper) biotypes.
I. Biotype 1 is capable of destroying varieties with the Bph1 gene.
II. Several distinct BPH biotypes have evolved globally due to extensive planting of resistant rice.
III. The Bph genes strictly confer non-preference without antibiosis.
Which of the above statement(s) is/are correct?
(A) I
(B) II and III
(C) II
(D) I and II

(C) A single major gene
(D) Extrachromosomal DNA

2021

103. Oligogenic resistance indicates that the trait is governed by:
(A) A few genes whose individual effects are significant and measurable
(B) A single dominant allele
(C) Dozens of minor genes strictly affected by environment
(D) Viral vectors incorporated into the plant genome

2018

104. Why is polygenic resistance generally more difficult for plant breeders to transfer into elite commercial cultivars?
(A) It causes complete lethality to the developing plant embryo.
(B) It is always maternally inherited through chloroplasts.
(C) It requires the simultaneous transfer of the insect's genes into the plant.
(D) It involves many genes with small individual effects, making phenotypic selection and introgression complex.

2024

105. Match the inheritance pattern (List I) with its defining characteristic (List II).
List I: (Inheritance Pattern)
P. Monogenic
Q. Oligogenic
R. Polygenic
S. Cytoplasmic
List II: (Characteristic)
1. Controlled by many genes with small additive effects
2. Controlled by a single major gene
3. Inherited exclusively through maternal organelles
4. Controlled by a few major genes
(A) P-2, Q-4, R-1, S-3
(B) P-4, Q-2, R-3, S-1
(C) P-1, Q-3, R-2, S-4
(D) P-2, Q-1, R-4, S-3

2002

106. In an F2 segregating population for a single dominant resistance gene against an insect pest, what phenotypic ratio of resistant to susceptible plants is expected?
(A) 1:2:1
(B) 9:3:3:1
(C) 3:1
(D) 1:1

2024

107. Quantitative traits in host plant resistance are typically associated with which genetic architecture?
(A) Monogenic inheritance
(B) Pure pseudoresistance
(C) Haploid expression
(D) Polygenic inheritance

2005

108. Which statement represents a misconception regarding the inheritance patterns of resistance?
(A) Recessive resistance genes cannot provide effective field-level protection.
(B) Resistance genes can be dominant, recessive, or additive.
(C) Polygenic traits are heavily influenced by environmental conditions.
(D) Monogenic traits follow classic Mendelian segregation.

2004

109. Mass rearing of an insect pest is a critical prerequisite for evaluating host plant resistance because:
(A) It genetically modifies the insects to become avirulent.
(B) It ensures an adequate, uniform, and precisely timed supply of insects for artificial infestation.
(C) It allows the plants to adapt to the pest in a controlled setting.
(D) It generates commercial by-products from the insect frass.

2023

110. Artificial infestation in greenhouse screening serves primarily to:
(A) Eliminate the need for standardized damage scoring scales.
(B) Ensure uniform pest pressure, avoiding escapes that occur in natural field settings.
(C) Induce horizontal resistance rapidly.
(D) Sterilize the test plants against secondary pathogens.

2018

111. A primary advantage of field screening layouts for host plant resistance is that they:
(A) Evaluate the plant's resistance under realistic agronomic and environmental conditions.
(B) Perfectly control temperature and humidity variables.

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(C) Prevent any interaction with natural enemies.
(D) Guarantee a 100% monogenic response.

2011

112. Which of the following is NOT a standard component of greenhouse screening protocols?
(A) Artificial diets or susceptible host plants for initial insect rearing
(B) Environmental control systems for temperature and photoperiod
(C) Reliance solely on natural, highly unpredictable windborne pest infestations
(D) Cages or confinement methods to prevent pest escape

2005

113. Standardized damage scoring scales (e.g., the 0-9 scale) are utilized globally in resistance evaluation to:
(A) Calculate the exact monetary value of the crop yield.
(B) Measure the precise amount of secondary metabolites in the leaf tissue.
(C) Induce the synthesis of systemic acquired resistance.
(D) Allow quantitative comparison of resistance levels across different years, locations, and breeding programs.

2002

114. In the Standard Evaluation System (SES) for rice against the brown planthopper, a score of '9' generally signifies:
(A) Complete immunity with no visible damage
(B) High resistance with very slight damage
(C) Moderate susceptibility with partial wilting
(D) High susceptibility resulting in complete plant death or "hopperburn"

2004

115. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Field screening for resistance is often supplemented with greenhouse screening.
Reason (R): Greenhouse screening allows for controlled, uniform pest pressure and prevents susceptible lines from escaping infestation.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2002

116. Pureline selection as a conventional breeding approach involves:
(A) Crossing two highly diverse species to induce hybrid vigor.
(B) Bombarding seeds with gamma radiation to induce new alleles.
(C) Continually backcrossing a hybrid to its susceptible parent.
(D) Selecting and isolating the superior progeny of a single self-pollinated homozygous resistant plant.

2023

117. The pedigree method of breeding is most typically applied to which type of crops following hybridization?
(A) Self-pollinated crops, where detailed records of ancestry are maintained through segregating generations.
(B) Vegetatively propagated crops
(C) Cross-pollinated crops exclusively
(D) Only to transgenic crops

2023

118. Which statement is an INCORRECT description of the backcross method in breeding for host plant resistance?
(A) It is primarily used to transfer a specific resistance gene into an otherwise elite, adapted cultivar.
(B) The adapted cultivar is used as the recurrent parent.
(C) It efficiently transfers complex polygenic resistance traits without linkage drag.
(D) Repeated crossing restores the genome of the recurrent parent while retaining the target gene.

2024

119. Mutation breeding for host plant resistance relies on:
(A) The use of physical or chemical mutagens to create novel genetic variation not present in the germplasm.
(B) The natural introgression of genes from wild relatives over centuries.
(C) The directed insertion of RNAi constructs via Agrobacterium.
(D) The selective spatial deployment of existing resistant varieties.

NODIA

2013

120. Linkage drag is a significant challenge when introgressing resistance genes from wild crop relatives because:

(A) The wild relative genes inevitably cause the plant to become highly susceptible to viruses.
(B) It prevents the plant from utilizing any form of pseudoresistance.
(C) The recurrent parent automatically rejects foreign pollen.
(D) Undesirable agronomic traits physically linked to the target resistance gene on the chromosome are transferred simultaneously.

2003

121. In a backcross breeding program targeting insect resistance, the primary role of the "recurrent parent" is to:
(A) Provide the novel source of resistance.
(B) Supply the vast majority of the desired agronomic and yield characteristics of the final variety.
(C) Serve as the wild species model.
(D) Induce random genetic mutations in the F1 progeny.

2005

122. The "donor parent" in a backcross breeding program is carefully selected based on its:
(A) High yield potential and commercial popularity.
(B) Complete susceptibility to the target insect pest.
(C) Possession of a strong, identifiable, and usually simply inherited resistance trait.
(D) Ability to undergo spontaneous mutation.

2007

123. Bacillus thuringiensis (Bt) Cry proteins utilized in transgenic host plant resistance are formally classified as:
(A) Volatile organic compounds
(B) Parasitic nematodes
(C) Secondary plant metabolites
(D) Crystalline delta-endotoxins

2001

124. The fundamental mode of action of Bt Cry proteins in susceptible insects involves:
(A) Activation in the alkaline midgut, binding to specific receptors, and pore formation in the epithelial cell membrane.
(B) Inhibition of acetylcholinesterase in the nervous system.
(C) Systemic suppression of the insect's juvenile hormone.
(D) Hardening of the insect exoskeleton preventing molting.

2017

125. Match the biotechnological resistance factor (List I) with its characteristic (List II).
List I: (Biotechnological Resistance Factor)
P. Cry1Ac
Q. Vegetative Insecticidal Protein (VIP)
R. Plant Lectin
S. RNAi
List II: (Characteristic)
1. Carbohydrate-binding protein that disrupts insect digestion
2. Targets specific mRNA to silence essential insect genes
3. Secreted during the vegetative growth phase of Bt, lacking crystal structure
4. Crystalline endotoxin primarily effective against lepidopteran larvae
(A) P-2, Q-3, R-1, S-4
(B) P-4, Q-1, R-3, S-2
(C) P-1, Q-4, R-2, S-3
(D) P-4, Q-3, R-1, S-2

2025

126. Vegetative Insecticidal Proteins (VIPs) differ from classical Cry proteins primarily because:
(A) They are synthesized only during the sporulation phase of Bt.
(B) They are secreted during the vegetative growth phase and target different midgut receptors.
(C) They are purely chemical alkaloids rather than proteins.
(D) They are strictly effective against root-knot nematodes, not insects.

NODIA

2002

127. Which of the following is NOT a recognized characteristic of plant lectins when used in biotechnological HPR?
(A) They act by physically dissolving the insect's exterior cuticle.
(B) They are carbohydrate-binding proteins.
(C) They can confer resistance against sap-sucking insects like aphids.
(D) They can bind to the peritrophic matrix or midgut epithelial cells.

2017

128. Why are specific Bt Cry proteins toxic to lepidopteran larvae but entirely harmless to humans?
(A) Humans can rapidly neutralize the protein using strong and highly reactive alkaline stomach acid.
(B) Humans possess a specialized system to

(C) I, III and V
(D) II and IV

2023

61. In evaluating a new crop variety for antibiosis, a researcher would most likely measure which parameter?
(A) The number of adults landing on the plant within 24 hours
(B) The survival rate and weight gain of nymphs confined to the plant
(C) The physical thickness of the leaf cuticle
(D) The number of compensatory tillers produced after damage

2007

62. Which definition accurately describes plant tolerance to insect herbivory?
(A) The rapid production of specific toxins that kill the insect after it begins feeding on the leaf.
(B) The plant's ability to repair or recover from pest damage without a proportional loss in yield.
(C) The occurrence of a genetic mutation that alters the host's primary visual and olfactory cues.
(D) The localized release of volatile signals that mask the plant from being detected by the insect.

2002

63. Compensatory growth is a common mechanism of tolerance. Which of the following is an example of compensatory growth?
(A) Production of secondary tillers or branches following the destruction of the apical meristem.
(B) The secretion of a hardened resin at the wound site to trap and kill the invading insect.
(C) The increased synthesis of defensive gossypol in uninjured leaves adjacent to the damage site.
(D) The dropping of injured leaves to eliminate the pest population entirely from the plant.

2010

64. Which of the following is LEAST likely to be considered a primary mechanism of plant tolerance?
(A) Altered photosynthate partitioning
(B) Rapid wound healing and necrosis isolation
(C) High concentration of digestive enzyme inhibitors
(D) Increased photosynthetic efficiency in remaining uninjured tissues

2001

65. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Tolerance is often considered an ideal resistance mechanism because it does not exert selection pressure on the insect population.
Reason (R): Tolerance operates by directly reducing the insect population size over successive generations.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019

66. How does altered photosynthate partitioning contribute to plant tolerance?
(A) By shifting resources from roots to leaves to poison the feeding insect with stored toxins
(B) By increasing the total amount of protective cuticular wax produced on the leaf surface
(C) By reallocating carbon reserves to storage organs or undamaged tissues to secure future growth
(D) By converting all available sugars into structural lignin to harden the entire plant stem

2003

67. A major agricultural advantage of utilizing tolerant crop varieties is that:
(A) They cause the localized extinction of the pest population within a single season.
(B) They allow a residual pest population to survive, supporting natural enemy conservation.
(C) They exhibit a strong and predictable boom and bust genetic cycle in the field.
(D) They require significantly higher insecticide application rates to maintain their health.

2002

68. Tritrophic interactions in agriculture fundamentally involve which three components?
(A) Soil, plant, and climate
(B) Primary metabolite, secondary metabolite, and elicitor
(C) Plant, herbivorous insect, and the soil nutrient profile

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the transgene.

2025

138. Metabolic detoxification as a resistance mechanism against plant defenses is most strongly associated with the upregulation of which insect enzyme families?
(A) DNA polymerases and helicases
(B) Amylases and lipases
(C) Cytochrome P450 monooxygenases, esterases, and glutathione S-transferases
(D) ATP synthases

2005

139. Which scenario INCORRECTLY describes cross-resistance in insect populations?
(A) An insect resistant to Cry1Ac is simultaneously resistant to Cry1Ab due to shared binding sites.
(B) A single genetic mutation confers resistance to multiple toxins with a common mode of action.
(C) An insect resistant to a Bt toxin automatically becomes resistant to all organophosphate chemical insecticides.
(D) Cross-resistance complicates the selection of stacked traits in pyramided crops.

2024

140. A target site mutation conferring resistance to a specific allelochemical typically provides what advantage to the insect?
(A) It prevents the allelochemical from binding to its intended physiological receptor, nullifying the toxic effect.
(B) It drastically increases the insect's physical size.
(C) It causes the plant to convert the allelochemical into a nutrient.
(D) It attracts more natural enemies to the insect.

2021

141. Routine resistance monitoring in field populations of target pests is conducted primarily to:
(A) Measure the yield of the transgenic crop.
(B) Detect early shifts in allele frequencies for resistance before field control failure occurs.
(C) Eradicate the pest using high-dose chemical sprays.
(D) Ensure the plants are producing enough epicuticular wax.

2012

142. A documented case of "field evolved resistance" implies that:
(A) The crop has evolved to produce more Bt toxin.
(B) A genetically stable decrease in susceptibility to a toxin has occurred in a wild pest population, often leading to reduced control efficacy.
(C) Resistance was artificially generated in a laboratory but never seen in agriculture.
(D) The insect has moved to a completely non-agricultural habitat.

2015

143. The high-dose/refuge strategy is a cornerstone of transgenic resistance management. What is its core principle?
(A) Using a high toxin dose to kill heterozygotes and a refuge to produce susceptible mates.
(B) Planting the entire field with high-dose transgenic seeds to eradicate the local pest population completely.
(C) Applying chemical pesticides at highly toxic doses in a small area of the field to reduce selection pressure.
(D) Using low doses of Bt so the insects slowly build tolerance over time.

NODIA

2005

144. In the context of transgenic crop management, 'stacked traits' refer to:
(A) Storing harvested seeds in vertical silos.
(B) The physical layering of trichomes on the leaf surface.
(C) Combining multiple transgenes (e.g., insect resistance and herbicide tolerance) into a single crop variety.
(D) Applying different chemical pesticides in sequential layers.

2007

145. Which of the following is considered a risk of the "refuge in a bag" (seed mixture) strategy?
(A) It guarantees 100% compliance by farmers regarding refuge planting.
(B) It requires extensive extra land strictly for the refuge.
(C) It entirely prevents cross-pollination.
(D) Larval movement between adjacent toxic and non-toxic plants can lead to sub-lethal exposure and accelerate resistance.

2016

146. In India, the primary regulatory body responsible for the approval and environmental release of genetically engineered crops is the:
(A) Indian Council of Agricultural Research

(ICAR)
(B) National Bureau of Plant Genetic Resources (NBPGR)
(C) Genetic Engineering Appraisal Committee (GEAC)
(D) Ministry of Agriculture and Farmers Welfare

2022

147. Strict regulatory compliance with refuge requirements is mandated because:
(A) It maximizes the immediate seasonal yield of the farmer.
(B) It is biologically essential to delay the development of insect resistance, preserving the long-term utility of the transgenic technology.
(C) The refuge crop acts as a fertilizer for the transgenic crop.
(D) It ensures the eradication of all secondary pests.

2024

148. A farmer planting Bt cotton in India is advised to plant a certain percentage of non-Bt cotton around the field perimeter. This acts as a:
(A) Physical barrier against wind
(B) Trap crop to kill all pests
(C) Source of hybrid vigor for the next generation
(D) Structured refuge to maintain a population of susceptible bollworms

2016

149. The historical success of breeding wheat resistant to the Hessian fly (Mayetiola destructor) relies heavily on:
(A) The deployment of a series of major designated H genes conferring strong antibiosis.
(B) Intense morphological defense via solid stems.
(C) Pure tolerance with no effect on the fly maggots.
(D) High-dose transgenic Cry proteins.

2007

150. A major consequence of utilizing single H genes for Hessian fly resistance in wheat has been:
(A) The complete global eradication of the Hessian fly.
(B) The elimination of the wheat stem sawfly.
(C) The sequential emergence of multiple Hessian fly biotypes capable of overcoming specific H genes.
(D) Complete resistance to all fungal pathogens.

2013

151. Resistance to the sorghum shoot fly (Atherigona soccata) is primarily attributed to which host plant mechanism?
(A) Non-preference for oviposition driven by specific morphological and chemical traits.
(B) Extreme antibiosis causing immediate larval mortality upon hatching.
(C) High levels of DIMBOA in the phloem.
(D) Genetically engineered RNAi constructs.

2013

152. Which of the following morphological features in sorghum is strongly correlated with resistance to the shoot fly?
(A) Solid stem pith
(B) Glossy leaf trait
(C) High levels of DIMBOA
(D) Cyanogenic glucosides

2013

153. Which statement INCORRECTLY details the mechanism of resistance against cotton jassids (Amrasca biguttula biguttula)?
(A) Resistance is fundamentally linked to the length and density of leaf hairs (trichomes).
(B) Jassid resistance is achieved by utilizing varieties with entirely glabrous (hairless) leaves.
(C) The resistance mechanism is primarily classified as antixenosis and physical interference.
(D) The physical barrier prevents the jassid from effectively inserting its stylets into the leaf veins.

2018

154. In breeding for cotton jassid resistance, an agronomist should select lines exhibiting:
(A) High levels of gossypol glands in the seed only
(B) Thin cuticles to allow rapid wound healing
(C) Long, dense, and erect trichomes on the leaf lamina and midrib
(D) High concentrations of glucosinolates

2011

155. The resistance of rice to the Brown Planthopper (BPH) is classically characterized by the integration of:
(A) Solely mechanical defenses like thickened sclerenchyma.
(B) Complete reliance on early maturation to escape damage.
(C) The production of insecticidal Bt endotoxins naturally.

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(D) Major dominant and recessive Bph genes conferring strong antibiosis and antixenosis.

2025

156. The identification and widespread incorporation of the Bph1 gene into high-yielding rice varieties is a classic milestone. What was the major limitation encountered?
(A) It was rapidly overcome by the emergence of BPH Biotype 2 within a few years of release.
(B) The gene caused severe yield penalty in the absence of pests.
(C) It inadvertently attracted the rice gall midge.
(D) It proved completely ineffective against Biotype 1.

2017

157. Resistance to the Green Leafhopper (GLH) in rice is agronomically vital primarily because:
(A) GLH larvae bore into the stem, causing "deadheart."
(B) GLH is the principal vector for transmitting the destructive Rice Tungro Virus disease.
(C) GLH feeding directly consumes the entire leaf lamina.
(D) GLH feeding prevents the rice plant from tillering completely.

NODIA

2014

158. Successful breeding for GLH resistance often subsequently results in field-level protection against Rice Tungro Virus. This is an example of disease control via:
(A) Direct antiviral chemical synthesis by the plant.
(B) Vector avoidance or deterrence (antixenosis/ antibiosis) disrupting the virus transmission cycle.
(C) Induced systemic resistance against the viral genome.
(D) RNA interference of the viral coat protein.

2017

159. Which of the following statements about rice resistance to the Asian gall midge is INCORRECT?
(A) Gall midge resistance is highly stable, with no biotypes ever recorded.
(B) Resistance is governed by a series of major Gm genes.
(C) The resistance primarily manifests as a hypersensitive response preventing the maggot from establishing a gall (silver shoot).
(D) The insect's biotypic variation strongly dictates which Gm genes are deployed regionally.

2014

160. When deploying a new Gm gene for gall midge resistance in an endemic area, agronomists use the strategy of gene pyramiding primarily to:
(A) Increase the aroma of the rice grain.
(B) Decrease the plant's reliance on silica.
(C) Delay the emergence of new, virulent gall midge biotypes.
(D) Ensure the plant matures before the monsoon season.

****

fecundity, and prolonging the time required for larval development. These physiological effects are typically the result of ingesting toxic plant secondary metabolites or experiencing nutritional deficiencies. By disrupting the herbivore's life cycle, antibiosis provides a powerful means of reducing pest population growth and subsequent damage to the crop.

56. (D) Plant traits that negatively impact the biology, growth, and reproduction of an insect.
Antibiosis is defined as the set of plant traits that exert a negative impact on the biology, growth, and reproductive success of an insect after it feeds on the host. This mechanism directly targets the herbivore's physiological processes, leading to reduced survival and lower population densities over time. It is a fundamental category of host plant resistance in agriculture.

57. (B) Binding to and inhibiting digestive enzymes in the insect midgut
Protease inhibitors in legume seeds confer antibiosis by binding to and inhibiting the essential digestive enzymes in the insect's midgut. This interaction prevents the herbivore from effectively breaking down and absorbing proteins, leading to nutritional starvation and stunted growth. Such chemical defenses are highly targeted and serve to protect the nutrient-rich seeds from being consumed by various pests.

58. (C) Lacks essential amino acids or vitamins required by the feeding insect
Nutritional imbalance functions as an antibiosis mechanism when a plant lacks the essential amino acids, vitamins, or minerals required for the insect's optimal growth. This deficiency forces the herbivore to consume more tissue to meet its needs or suffer from reduced development and survival. Breeding for specific nutritional profiles can be an effective way to enhance resistance against pests.

59. (D) It extends the window of vulnerability of the larvae to natural enemies and weather.
Prolonging the larval developmental period through antibiosis provides an ecological advantage by extending the window of vulnerability to natural enemies and adverse weather conditions. As the insect remains in its immature stages for longer, it is more likely to be attacked by predators or parasitoids. This synergy between host plant resistance and biological control is essential for integrated management.

60. (C) I, III and V
Antibiosis generally requires the insect to ingest plant material to experience the negative physiological effects of toxins or digestibility reducers. Specific examples include chemical compounds in corn that provide resistance against the European corn borer. These mechanisms target various stages of the insect's life cycle, emphasizing the importance of chemical composition in determining the overall suitability and resistance of hosts.

61. (B) The survival rate and weight gain of nymphs confined to the plant
To evaluate a new crop variety for antibiosis, researchers typically measure the survival rate and weight gain of insect nymphs or larvae confined to the plant. These biological parameters provide a direct assessment of how the plant's chemical and nutritional properties affect herbivore growth and development. Significant reductions in these metrics compared to controls indicate the presence of antibiosis.

62. (B) The plant's ability to repair or recover from pest damage without a proportional loss in yield.
Plant tolerance is the ability of a crop to repair damage or recover from insect herbivory without experiencing a proportional loss in yield. Unlike antibiosis or antixenosis, tolerance does not actively target the insect population or influence its behavior. Instead, it focuses on the plant's own physiological resilience and capacity for compensatory growth to maintain productivity despite the presence of pests.

63. (A) Production of secondary tillers or branches following the destruction of the apical meristem.
Compensatory growth is exemplified by the production of secondary tillers or branches following the destruction of the apical meristem by an insect. This response allows the plant to replace lost tissues and maintain its photosynthetic capacity, thereby mitigating the impact of injury on final yield. Such developmental plasticity is a key mechanism of tolerance in many cereal and grain crops.

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suitability of the host for feeding or oviposition through direct physical interaction.

9. (B) Presence of multiple pores along the setal shaft
Olfactory sensilla are characterized by the presence of numerous microscopic pores distributed along the setal shaft, allowing volatile molecules to reach internal dendrites. In contrast, mechanosensilla typically lack these pores and respond to physical displacement. This structural difference is fundamental to how insects distinguish between chemical signals in the air and physical contact with plant surfaces.

10. (A) Both A and R are true and R is the correct explanation of A.
Contact chemoreceptors located on an insect's tarsi are vital for the final assessment of host suitability during the recognition phase. These sensors detect non-volatile primary and secondary metabolites present on the leaf cuticle upon landing. The resulting sensory input provides the insect with essential chemical information required to either accept or reject the plant for feeding purposes.

11. (B) Sensilla basiconica
Sensilla basiconica are peg-like structures primarily responsible for detecting volatile chemical cues emitted by host plants from a distance. These olfactory receptors contain multiple pores that allow air-borne molecules to interact with sensory neurons. They play a pivotal role in the habitat location and host finding phases of the behavioral sequence leading to successful plant colonization.

12. (A) Gustatory assessment and feeding continuation
Sensilla styloconica found on the mouthparts of larvae function as gustatory receptors that evaluate the chemical composition of plant tissues during probing. Damage to these organs prevents the insect from accurately perceiving stimulants or deterrents, thereby disrupting the decision to continue feeding. This sensory input is essential for the transition from initial recognition to sustained consumption and development.

13. (B) Insects utilize visual cues to locate hosts only after olfactory cues are exhausted.
A common misconception is that visual inputs are only utilized after olfactory cues fail, whereas insects actually integrate multiple sensory modalities simultaneously. Visual factors such as plant shape, color contrast, and spectral reflectance assist in long-range orientation and short-range discrimination. These cues work in tandem with chemical signals to guide the herbivore toward suitable host plants.

NODIA

14. (B) Host acceptance and sustained feeding or oviposition
Following the successful recognition of a suitable host plant, the insect enters the phase of host acceptance. This behavioral transition is characterized by the initiation of sustained feeding or the commencement of oviposition on the plant surface. This step is critical because it marks the definitive commitment of the herbivore to utilize the specific plant for its life cycle.

15. (A) P-2, Q-3, R-1, S-4
Habitat location involves long-range signals like olfaction and vision to find the general area. Host location relies on short-range directed flight toward specific plants. Recognition is mediated by contact chemoreception to verify chemical suitability. Finally, oviposition requires the assessment of physical plant textures to ensure the site is appropriate for egg deposition and future larval survival.

16. (C) Wind currents and phototactic responses
During the initial phase of habitat location, dispersing insects are strongly influenced by abiotic factors such as wind currents and light gradients. These environmental cues guide the movement of the herbivore toward potential host-growing areas before specific plant odors become detectable. Phototactic and anemotactic responses are fundamental behavioral mechanisms that facilitate the large-scale distribution of insect populations.

17. (D) Arrestment and localized exploration of the plant surface
The transition from locating a host to recognizing its suitability depends on the insect's arrestment and subsequent localized exploration of the plant. During this phase, the insect slows its movement and utilizes its sensory organs to probe the surface for specific chemical markers. This process is essential for determining whether the encountered plant meets the requirements for feeding.

ANSWERS

1. (D) The heritable qualities of a plant that determine the degree of damage sustained from specific insect pests
Host plant resistance describes the inherited characteristics of plants that influence the level of damage caused by specific insect populations. This biological trait encompasses various mechanisms that prevent or reduce pest injury compared to susceptible plants. It represents a long-term defensive strategy resulting from the plant's evolutionary interactions with herbivores within its ecosystem.

2. (C) Antibiosis
Antibiosis represents a category of resistance where the plant's chemical or physical properties negatively influence the basic biology of the feeding insect. These effects typically manifest as reduced survival, decreased growth rates, or lowered reproductive capacity after ingestion. Unlike other mechanisms, this process actively disrupts the life cycle and physiological development of the herbivore population.

3. (B) Resistance has been proved to be strictly dependent on vertical gene deployment.
Resistance is not solely reliant on vertical gene deployment, as it also involves horizontal resistance and various ecological factors. Historical milestones have confirmed that these traits are heritable and comprise diverse mechanisms such as non-preference and antibiosis. Breeding programs utilize both major and minor genes to ensure stability and effectiveness against evolving pest populations in agriculture.

4. (D) It is compatible with other control tactics and continuously cumulative over successive seasons.
Host plant resistance serves as a foundational component of integrated pest management because it remains compatible with biological, cultural, and chemical control methods. The effectiveness of resistant varieties is cumulative over successive cropping seasons, helping to maintain insect populations below economic thresholds. This sustainable approach reduces reliance on synthetic pesticides while providing continuous protection for crops.

5. (A) I and III
Significant historical examples include the early identification of Hessian fly resistance in wheat as a successful management strategy. Additionally, tolerance is defined as a plant's ability to maintain productivity despite damage, meaning it does not actively suppress insect populations. While terminology has evolved, the core principles of plant-herbivore interactions remain fundamental to modern agricultural entomology research.

6. (C) Host evasion
Host evasion occurs when a susceptible plant variety completes its most vulnerable growth stages before the peak population of a specific pest develops. This phenological mismatch allows the crop to avoid significant injury without possessing genetic resistance traits. Such ecological escape is often managed through adjusted planting dates to synchronize growth with periods of low insect activity.

7. (A) Electroantennography
Electroantennography is a vital laboratory technique used to record the electrical response of insect antennae to various volatile compounds. By measuring action potentials from chemosensilla, researchers can identify which specific plant chemicals are perceived by the insect's sensory system. This method is essential for understanding how herbivores locate and recognize their host plants in complex environments.

8. (D) Sensing physical plant attributes such as trichome density and surface texture during exploration
Mechanoreceptors are specialized sensory organs that enable insects to perceive physical stimuli and structural features of the plant surface. These receptors play a critical role during the exploration phase by detecting trichome density, surface texture, and tissue hardness. This information helps the insect determine the

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27. (D) By informing optimal planting dates to achieve host evasion
Applying the concepts of pseudoresistance allows agriculturalists to determine optimal planting dates that achieve host evasion. By synchronizing crop development with periods of low pest activity, farmers can significantly reduce damage without relying exclusively on genetic resistance or chemical applications. This ecological approach is a vital component of sustainable pest management, helping to maximize yields through strategic planning.

28. (A) Glandular and non-glandular trichomes
Trichomes are hair-like appendages on the plant surface that provide a physical defense by trapping small insects or restricting their movement. Glandular trichomes further enhance this effect by secreting sticky substances or toxins that can immobilize herbivores upon contact. These structures serve as an effective barrier that prevents insects from reaching the leaf surface to feed or lay eggs.

29. (B) Yellow stem borer
The deposition of silica in the epidermal cells of rice leaves and stems provides a physical barrier against the yellow stem borer. This mineralization hardens the plant tissues, making it difficult for the larvae to bore into the stem. Additionally, silica acts as a digestibility reducer, wearing down the insect's mandibles and hindering its ability to extract nutrients effectively.

30. (A) II, III, I, IV
An insect encountering a typical leaf surface first meets the epicuticular wax, followed by the cutin layer. Below these lies the epidermal cell wall, which must be breached to reach the internal mesophyll cells where most feeding occurs. This sequence of structural layers represents a series of physical barriers that determine the ease of penetration and host acceptance.

31. (A) Wheat stem sawfly
Solid stems in specific wheat varieties function as a physical defense against the wheat stem sawfly. The presence of pith inside the stem prevents the female sawfly from successfully depositing eggs and interferes with the movement of larvae within the plant. This morphological trait has been a highly effective tool in breeding programs to reduce insect-related yield losses.

32. (C) Highly crystalline epicuticular wax blooms
Crystalline epicuticular wax blooms on the leaf surface significantly reduce the efficiency of insect tarsal adhesion. The slippery nature of these wax structures causes many insects to lose their grip and fall off the host plant before they can begin feeding. This physical mechanism serves as an important antixenosis trait, deterring colonization and reducing overall pest pressure.

33. (D) Preventing the insect ovipositor from reaching and damaging the developing seeds
A thick pod wall in chickpea serves as a physical defense by preventing the insect ovipositor from reaching and damaging the developing seeds inside. This mechanical barrier increases the distance and effort required for the pest to deposit eggs, often leading to reduced infestation levels. Such morphological traits are critical for protecting high-value reproductive parts from specialized insects.

34. (C) Glandular types secrete exudates with allelochemicals, providing both physical and chemical defense.
Glandular trichomes differ from non-glandular types by producing and secreting specialized exudates containing allelochemicals and sticky resins. These secretions provide a dual layer of protection by acting as both a chemical toxin and a physical trap for herbivores. Non-glandular trichomes primarily provide resistance through mechanical interference and by increasing the distance between the insect and leaf.

35. (A) I, II, III and IV
Physical defenses involve multiple mechanisms, including silica for reducing digestibility and trichomes for impeding insect movement. Solid stems provide a barrier against stem-boring insects, while thick cell walls can deter the penetration of aphid stylets. These structural features collectively enhance the plant's ability to resist herbivory by making the host more difficult to consume or navigate effectively.

36. (D) Kairomone
A kairomone is an allelochemical emitted by a plant that provides an adaptive advantage to the receiving insect while being disadvantageous to the emitter. These compounds often serve as cues for the insect to locate a host plant, initiate feeding, or find a mate. The evolutionary

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18. (C) The detection of specific token stimuli or kairomones present on the leaf surface
The ultimate acceptance of a plant for oviposition is often dictated by the perception of specific token stimuli or kairomones on the leaf surface. These chemical signals provide the female insect with reliable information regarding the host species and its nutritional quality. Such interactions ensure that the resulting offspring are placed on a plant that can support development.

19. (B) Host recognition and acceptance
When an insect lands on a plant but departs without probing, the disruption occurs during the host recognition and acceptance phase. The insect has successfully located the plant but fails to receive the necessary chemical or physical stimuli to trigger feeding behavior. This rejection indicates that the plant lacks the required stimulants or possesses deterrents that prevent colonization.

20. (B) Habitat location → Host location → Host recognition → Acceptance
The behavioral sequence of host selection begins with habitat location, followed by the identification of specific plants during host location. Once on the plant, host recognition occurs through the detection of chemical and physical cues. The final stage is acceptance, where the insect commits to sustained feeding or oviposition, completing the process of establishing a relationship with the host.

21. (A) True antibiosis
True antibiosis is a genetic form of resistance that negatively affects insect biology, distinguishing it from ecological resistance or pseudoresistance. Pseudoresistance categories include host evasion, host escape, and induced temporary resistance, which rely on environmental factors or phenological timing rather than heritable defensive traits. Understanding these distinctions is important for developing integrated pest management strategies utilizing all tactics.

22. (C) Unequal pest distribution that leaves some susceptible individual plants randomly uninfested
Host escape is characterized by the random failure of insects to find and infest certain susceptible plants within a population. This phenomenon results from unequal pest distribution or low population density rather than any inherent defensive qualities of the plant. Although the individual plants remain uninjured, they do not possess genetic resistance and their offspring remain entirely susceptible.

23. (A) Variations in soil moisture and nutrient availability affecting the plant's sap composition
Environmentally induced temporary resistance occurs when external factors like soil moisture or nutrient levels alter the plant's physiological state. These changes can modify the sap composition or tissue quality, making the plant less suitable for specific pests for a limited period. This form of pseudoresistance is not heritable and fluctuates based on the prevailing conditions in the field.

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24. (D) Host evasion
Host evasion is demonstrated when a rice variety is planted early enough to pass its susceptible stage before the gall midge population emerges. This strategy utilizes phenological synchrony to avoid damage by ensuring the pest and the vulnerable plant stage do not coexist in time. It is a critical cultural control method used to manage specific pests.

25. (D) I and III
Pseudoresistance is not under strict monogenic control because it is driven by environmental and ecological factors rather than specific genes. Furthermore, environmental factors are the primary cause of temporary resistance, contradicting the idea that they cannot modify it. Host evasion and host escape remain valid examples of how plants avoid injury through timing or chance rather than genetic defenses.

26. (C) It is a form of environmentally induced temporary resistance.
When a plant's resistance is eliminated by high nitrogen application, it indicates that the trait is a form of environmentally induced temporary resistance. The surplus nitrogen likely alters the nutritional balance or reduces defensive compounds, making the plant susceptible to aphids. This highlights how agronomic practices can significantly influence the expression and effectiveness of certain non-heritable resistance mechanisms.

46. (B) Reducing nutrient assimilation by binding to dietary proteins and digestive enzymes
Tannins defend plants by binding to dietary proteins and digestive enzymes in the insect gut, which significantly reduces the assimilation of nutrients. This process leads to decreased growth rates and lower overall fitness for the feeding herbivore. As digestibility reducers, tannins are a widespread form of chemical defense that provides protection against a broad range of chewing insect pests.

47. (A) Sinigrin - Sorghum
The pairing of sinigrin with sorghum is incorrect because sinigrin is a glucosinolate typically found in cruciferous plants, not in sorghum. Sorghum is instead known for producing cyanogenic glucosides like dhurrin as a chemical defense. Other correctly identified pairings include DIMBOA in wheat and maize, gossypol in cotton, and tomatine in tomato plants, which provide resistance against specific insects.

48. (C) It breaks down glucosinolates into toxic isothiocyanates when the plant tissue is damaged.
In cruciferous plants, the enzyme myrosinase plays a critical role in defense by breaking down stored glucosinolates into toxic isothiocyanates when tissue damage occurs. This mechanism ensures that high concentrations of toxins are released precisely at the site of herbivore attack. This rapid chemical reaction provides an immediate and effective deterrent against many generalist insects attempting to feed.

49. (D) Plant traits that cause an insect to select an alternative host for feeding or oviposition.
Antixenosis refers to plant traits that negatively affect insect behavior, leading the herbivore to select an alternative host for feeding or oviposition. This mechanism, often called non-preference, can be mediated by both morphological features and chemical repellents. By making the plant less attractive or more difficult to colonize, antixenosis reduces the likelihood of an infestation becoming established.

50. (A) II and III
Antixenosis is correctly associated with morphological features like dense trichomes that interfere with insect landing or movement. It functions during the critical phases of host location and acceptance by influencing the herbivore's behavioral choices. Unlike antibiosis, it does not necessarily involve toxic ingestion or increased mortality, but rather serves to redirect the insect away from the protected plant species.

51. (B) Deterrent
A deterrent is a chemical compound on the plant surface that inhibits an insect from continuing its feeding or oviposition behavior after physical contact has occurred. These substances act on the insect's gustatory or tactile receptors to signal that the host is unsuitable. Deterrents are key components of antixenosis, helping to protect plants by stopping damage shortly after contact.

52. (D) Repellents act at a distance via volatiles, while deterrents require physical contact.
Olfactory repellents differ from contact deterrents in that they act at a distance through the emission of volatile compounds that insects detect from the air. In contrast, deterrents require the insect to make physical contact with the plant surface or begin probing to perceive the signal. Both mechanisms contribute to host rejection but operate at different stages of selection.

53. (A) Adults may lay eggs on the resistant crop at reduced rates if no alternative hosts exist.
In a monoculture field where no alternative hosts are available, an insect may eventually lay eggs on a variety with antixenosis traits, though at a significantly reduced rate. This occurs because the drive to reproduce may eventually override the avoidance behavior triggered by the plant. This limitation emphasizes why antixenosis is more effective when alternative hosts are present.

54. (C) Denied alternative hosts, pests may eventually accept the resistant variety.
The use of antixenosis in large-scale monocultures carries the risk that pests will eventually accept the resistant variety when denied all other host options. Without alternative plants for colonization, the selection pressure for the insect to overcome the deterrent signals increases. This behavioral adaptation can reduce the long-term effectiveness of non-preference as a standalone management strategy in simplified agricultural environments.

55. (C) I, II and III
Antibiosis negatively impacts insect biology by increasing juvenile mortality, reducing adult

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stability of kairomones is maintained because they typically serve essential primary functions.

37. (A) It provides an adaptive advantage to the emitter but not the receiver.
Allomones are chemical signals that provide an adaptive advantage to the emitting plant by negatively affecting the behavior or physiology of the receiving insect. Common examples include repellents that deter feeding or toxins that reduce herbivore survival. These substances are central to the plant's active defense strategy, helping to reduce the overall damage sustained from various insect populations.

38. (C) A synomone and a kairomone depending on the receiver
A volatile compound that attracts both a herbivore and its natural enemy functions as both a kairomone and a synomone. It acts as a kairomone for the herbivore, which uses the signal to locate a host, but serves as a synomone for the natural enemy, which benefits by finding prey. This complex interaction illustrates how chemical signals mediate relationships.

39. (A) A floral scent that attracts a pollinating insect
A floral scent that attracts a pollinating insect is a classic example of a synomone, as it provides a mutual benefit to both the plant and the insect. The plant achieves pollination and successful reproduction, while the insect receives a reward such as nectar or pollen. Synomones are key mediators of beneficial interspecific interactions essential for ecosystem health.

40. (C) A is true but R is false.
Kairomones can indeed increase a crop's vulnerability by helping pests locate their hosts, which makes the first statement true. However, the definition provided in the second statement is incorrect, as kairomones provide an adaptive advantage to the receiver, not the emitter. Understanding this distinction is vital for analyzing how chemical communication affects the overall susceptibility of crop plants.

41. (B) Kairomones
Glucosinolates in cruciferous plants act as kairomones for specialized insects like the cabbage butterfly by stimulating their feeding and oviposition behaviors. While these compounds are toxic to generalist herbivores, specialists have evolved to use them as reliable indicators of their host plants. This demonstrates how a single chemical can have different ecological roles depending on the insect species interacting.

42. (C) They are not essential for basic growth but mediate ecological interactions and defense.
Secondary plant metabolites are distinguished from primary metabolites because they are not directly involved in essential processes like photosynthesis, respiration, or basic growth. Instead, they play critical roles in mediating ecological interactions, including defense against herbivores and pathogens. Their production is often specialized and varies significantly between different plant species, reflecting their diverse roles in adaptation and survival.

43. (D) Alkaloids
Alkaloids are a major class of nitrogen-containing secondary metabolites that are well-known for their potent toxicity to the nervous systems of insects and other animals. These compounds often interfere with neurotransmission or enzyme activity, serving as a powerful chemical defense for the plant. Common examples found in nature include nicotine, caffeine, and morphine, which exhibit diverse biological activities.

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44. (A) Terpenoids
Gossypol is a polyphenolic compound that belongs to the terpenoid class of secondary metabolites and is found specifically in cotton plants. It confers resistance against various insect pests by inhibiting enzyme activity and disrupting cellular processes in the herbivore. The presence of gossypol glands in cotton tissues is a key target for breeders seeking to enhance host plant resistance.

45. (A) P-2, Q-4, R-3, S-1
Alkaloids include compounds like nicotine, while pyrethrins are examples of terpenoids with insecticidal properties. Phenolics are represented by tannins, which act as digestibility reducers in many plant species. Glucosinolates, such as sinigrin, are characteristic of the Brassicaceae family and serve as important defensive chemicals against generalist herbivores while sometimes attracting specialized insects to the target host plant.

64. (C) High concentration of digestive enzyme inhibitors
High concentrations of digestive enzyme inhibitors are characteristic of antibiosis rather than tolerance, as they directly harm the insect's biology. In contrast, primary tolerance mechanisms include altered photosynthate partitioning, rapid wound healing, and increased photosynthetic efficiency in uninjured tissues. These processes focus on the plant's internal reallocation of resources to survive and thrive despite being fed upon by insect herbivores.

65. (C) A is true but R is false.
Tolerance is considered an ideal resistance mechanism because it does not exert selection pressure on insects, which prevents the rapid evolution of virulent biotypes. However, the reason provided is false because tolerance does not directly reduce the insect population size. By allowing a residual population to survive, tolerance helps maintain natural enemy populations and promotes long-term ecological stability in fields.

66. (C) By reallocating carbon reserves to storage organs or undamaged tissues to secure future growth
Altered photosynthate partitioning contributes to plant tolerance by reallocating carbon reserves to storage organs or undamaged tissues to secure future growth. This strategic movement of resources allows the plant to protect its most valuable energy supplies from herbivores and ensures that it can still produce a viable crop. This physiological response is essential for maintaining yield under continuous insect infestation.

67. (B) They allow a residual pest population to survive, supporting natural enemy conservation.
A major advantage of utilizing tolerant varieties is that they allow a residual pest population to survive, which supports the conservation of natural enemies. By providing a stable food source for predators and parasitoids, tolerant crops help maintain biological control within the ecosystem. This approach reduces the likelihood of pest outbreaks and decreases the need for frequent insecticide applications.

68. (D) Plant, herbivorous insect, and the natural enemy of the herbivore
Tritrophic interactions in agriculture fundamentally involve the plant, the herbivorous insect, and the natural enemy of that herbivore, such as a predator or parasitoid. These interactions are mediated by various signals and defenses that influence the success of each group. Understanding the complex relationships between these three levels is crucial for developing effective and sustainable biological control strategies in fields.

69. (A) Act as specific signals that recruit parasitoids or predators to the infested host plant.
Herbivore-induced plant volatiles (HIPVs) are crucial in tritrophic interactions because they act as specific chemical signals that recruit parasitoids or predators to the infested plant. These volatiles are released in response to feeding damage and provide natural enemies with reliable information about the location of their prey. This indirect defense mechanism helps to reduce the herbivore population and protect plants.

70. (B) P-4, Q-1, R-2, S-3
Constitutive volatiles are baseline emissions from undamaged plants, while HIPVs are released specifically in response to herbivore feeding. Green leaf volatiles (GLVs) are six-carbon compounds rapidly emitted from physically broken cells. Systemic emission occurs when uninjured parts of a plant release volatiles following localized damage elsewhere. These different signals play unique roles in plant communication and insect attraction or deterrence.

71. (A) The specific elicitors present in the insect's oral secretions
The specificity of herbivore-induced plant volatile (HIPV) blends is often determined by the unique elicitors present in the insect's oral secretions. When these molecules interact with plant tissues during feeding, they trigger specific signaling pathways that result in characteristic volatile profiles. This specificity allows natural enemies to distinguish between different types of herbivores and locate their preferred hosts more efficiently.

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90. (D) II
The statement that temporal rotation involves using the same resistance gene continuously for decades is incorrect, as rotation requires changing genes over time. True temporal rotation involves alternating different resistance genes between successive seasons to prevent any single biotype from becoming fixed. This strategy, along with spatial rotation and gene pyramiding, is essential for sustainable and durable pest management.

91. (D) Growing varieties with different resistance genes in different distinct geographical zones
Spatial gene deployment involves growing crop varieties with different resistance genes in distinct geographical zones across a region. This approach creates a mosaic of defenses that prevents the large-scale development and spread of a single virulent biotype. By limiting the area where any one gene is used, the overall selection pressure on the pest population is significantly reduced.

92. (A) Altering selection pressure between seasons to prevent a biotype from fixing in the population.
Temporal rotation of resistance genes aims to alter the selection pressure on insect populations between seasons to prevent a specific biotype from becoming dominant. By changing the resistance traits encountered by the pest from one year to the next, the plant's defenses remain effective for a longer period. This strategy disrupts the evolutionary trajectory of the insect population.

93. (B) Insects must simultaneously acquire multiple virulence mutations, which is statistically improbable.
Gene pyramiding is considered superior to sequential release because it requires an insect to simultaneously acquire multiple virulence mutations to overcome the plant's defenses. The statistical probability of such multiple mutations occurring at once is extremely low compared to step-by-step adaptation. This makes pyramided crops much more durable and resistant to the emergence of new, virulent biotypes in fields.

94. (A) Switch to a cultivar with a different major Bph resistance gene
When a previously resistant rice cultivar suffers heavy damage from the brown planthopper, the most appropriate remedial measure is to switch to a cultivar containing a different major Bph resistance gene. This change bypasses the virulent biotype that has developed and provides immediate protection. Long-term management should then focus on integrated strategies and gene rotation to prevent similar breakdowns.

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95. (B) I, II and IV
Vertical resistance is typically controlled by a single major gene and is race-specific, making it vulnerable to rapid breakdown by new biotypes. In contrast, horizontal resistance is polygenic and provides more durable, race-non-specific protection against a broad spectrum of pests. Understanding these genetic architectures is essential for breeders to choose the right strategy for developing stable and long-lasting crop varieties.

96. (C) It confers a high level of resistance against specific pest biotypes but is vulnerable to rapid breakdown.
Vertical resistance provides a high level of protection against specific pest biotypes but is vulnerable to rapid breakdown when the insect evolves to overcome the single major gene involved. This type of resistance is often characterized by an "all or nothing" response and follows the gene-for-gene model. While effective in the short term, its lack of durability remains a challenge.

97. (D) It exerts intense selection pressure resulting in rapid biotype evolution.
The statement that horizontal resistance exerts intense selection pressure resulting in rapid biotype evolution is incorrect. Because horizontal resistance is polygenic and provides only moderate protection, it exerts less selection pressure on the pest population than vertical resistance. This lower pressure makes it much more stable and durable over time, as insects cannot easily overcome many genes simultaneously.

98. (C) Monogenic or oligogenic
Race-specific resistance traits are most likely to exhibit monogenic or oligogenic inheritance patterns, where only one or a few genes control the trait. This genetic simplicity allows for a high level of resistance against specific biotypes but also makes the resistance easier for the pest to overcome. These traits are typically transferred into elite varieties using standardized breeding methods.

81. (D) Phytohormonal crosstalk
The phenomenon where the activation of the salicylic acid pathway suppresses the jasmonic acid pathway is known as phytohormonal crosstalk. This antagonistic interaction allows the plant to prioritize its defensive resources based on the specific type of threat it encounters. However, this crosstalk can also be exploited by certain pests to overcome plant defenses, making it a critical research area.

82. (C) An insect population that differs in its ability to utilize a specific resistant variety.
An insect biotype is defined as a population of a pest species that differs from others in its ability to utilize a specific resistant plant variety. These biotypes are often genetically distinct and emerge through natural selection when exposed to crops with major resistance genes. Identifying and monitoring biotypes is essential for managing the long-term effectiveness of resistant crop varieties.

83. (B) Allelic changes that overcome specific plant resistance genes (often gene-for-gene interaction)
The genetic basis of a newly evolved insect biotype is typically linked to allelic changes that allow the pest to overcome specific plant resistance genes. This interaction often follows a gene-for-gene model, where a mutation in the insect's virulence gene nullifies the effect of the plant's resistance gene. These genetic shifts are the primary reason for vertical resistance breakdown.

84. (D) Widespread and continuous planting of crop varieties with a single major resistance gene (vertical resistance).
The primary evolutionary driver for the rapid emergence of new insect biotypes is the widespread and continuous planting of crop varieties containing a single major resistance gene. This "vertical resistance" exerts intense selection pressure on the pest population, favoring individuals with mutations that can bypass defense. Over time, these virulent individuals multiply, eventually rendering previously resistant cultivars susceptible.

85. (C) II
Several distinct brown planthopper biotypes have evolved globally as a direct result of the extensive planting of resistant rice varieties. These biotypes are characterized by their ability to survive on and damage rice plants that possess specific Bph resistance genes. Monitoring the distribution of these biotypes is a critical component of rice breeding and pest management efforts globally.

86. (C) Developing multiple regional biotypes that vary in their response to specific Gm genes.
The Asian rice gall midge is notorious for developing multiple regional biotypes that vary in their ability to overcome specific Gm resistance genes. These biotypes are often geographically localized, meaning that a rice variety may be resistant in one area but susceptible in another. This high degree of variation necessitates regional testing and strategic deployment of resistance genes.

87. (A) A plant resistance gene (R) is overcome by an insect virulence gene (v).
Under the gene-for-gene concept, the survival of the insect is dictated by the interaction between a specific plant resistance gene and a corresponding insect virulence gene. Resistance occurs only when the plant possesses the resistance gene and the insect lacks the virulence mutation. If the insect evolves a virulence gene that bypasses the plant's defense, the resistance is lost.

88. (D) A set of standardized differential host varieties with known resistance genes
To characterize a suspected new insect biotype, researchers use a set of standardized differential host varieties that possess known, individual resistance genes. By observing the insect's ability to survive and cause damage on each variety, they can determine its virulence profile and distinguish it from known biotypes. This systematic approach is essential for identifying shifts in pest populations.

89. (B) The strategic spatiotemporal allocation of specific resistance genes in crop varieties to delay biotype selection
Gene deployment refers to the strategic spatiotemporal allocation of specific resistance genes in crop varieties to delay the evolution of virulent insect biotypes. By alternating or mixing different genes across the landscape and over time, farmers can reduce the consistent selection pressure that leads to resistance breakdown. This proactive approach is vital for maintaining the long-term utility of genetic defenses.

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72. (D) Use of broad-spectrum insecticides that eliminate local natural enemy populations
The use of broad-spectrum insecticides can directly disrupt the protective function of HIPVs by eliminating the local natural enemy populations that respond to these signals. Without predators or parasitoids to act on the information, the plant's indirect defense becomes ineffective. This disruption highlights the importance of choosing selective pesticides that preserve beneficial insects while managing the primary pest population.

73. (B) Cellulose
Cellulose is a structural polysaccharide that makes up the plant cell wall and does not function as an induced volatile signal in tritrophic defense. In contrast, compounds like indole, linalool, and methyl salicylate are typical volatiles emitted by plants in response to herbivory. These molecules serve as chemical messengers that can attract natural enemies or alert neighboring plants to threats.

74. (C) Mutualism
The interaction between plants emitting HIPVs and the parasitoids that respond to them is best described as mutualism. The plant benefits from the reduction in herbivore damage as the parasitoid attacks the pest, while the parasitoid benefits from finding a reliable host for its offspring. This mutually beneficial relationship is a key component of natural pest suppression in agricultural ecosystems.

75. (A) Local infection → Salicylic acid accumulation → Pathogenesis-related (PR) protein synthesis → Systemic protection
Systemic Acquired Resistance (SAR) begins with a localized infection, which triggers the accumulation of salicylic acid throughout the plant. This signaling molecule then induces the synthesis of pathogenesis-related (PR) proteins in uninfected tissues. The final result is a state of heightened systemic protection that allows the entire plant to better resist subsequent attacks by a broad range of attackers.

76. (A) A molecule from the pest or pathogen that is recognized by the plant, triggering defense responses
An elicitor is a molecule derived from a pest or pathogen that is recognized by the plant's sensory system, triggering a cascade of defense responses. These molecules can include proteins, lipids, or carbohydrates that signal the presence of an attacker. The recognition of elicitors is the first step in the induction of both localized and systemic resistance in crops.

77. (B) ISR is typically triggered by beneficial soil microbes, whereas SAR is triggered by localized pathogen infection.
Induced Systemic Resistance (ISR) primarily differs from Systemic Acquired Resistance (SAR) in its triggering mechanism, as it is typically initiated by beneficial soil microbes like rhizobacteria. While SAR is usually activated by localized pathogen infections and relies on salicylic acid, ISR often involves jasmonic acid and ethylene signaling pathways. Both provide systemic protection but respond to different environmental stimuli.

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78. (B) Jasmonic acid pathway
The jasmonic acid (JA) pathway is the primary phytohormone system activated in response to attack by chewing insects and necrotrophic pathogens. This signaling network induces the expression of numerous defense genes, such as those encoding protease inhibitors and other toxic compounds. The JA pathway is essential for the plant's ability to recognize and respond to physical tissue damage and herbivory.

79. (A) Biotrophic pathogens and piercing-sucking insects like aphids
The salicylic acid (SA) pathway is generally most effective against biotrophic pathogens and piercing-sucking insects like aphids. These attackers typically cause less physical tissue damage than chewing insects, and the SA-mediated response is specifically tailored to counteract their unique feeding styles. Understanding which pathway is activated by different pests is important for predicting the effectiveness of plant defenses in agriculture.

80. (A) II, I, IV, III
The jasmonate signaling pathway begins with herbivore damage and the recognition of elicitors, followed by the release of linolenic acid from chloroplast membranes. This fatty acid serves as the precursor for the biosynthesis of jasmonic acid (JA). Once JA is produced, it activates the expression of various defense genes, such as those for protease inhibitors, providing insect protection.

99. (B) Employs a broad, generalized defense mechanism effective against multiple biotypes of a pest.
Race-non-specific resistance implies that the plant employs a broad and generalized defense mechanism that is effective against multiple biotypes of a specific pest. This type of resistance is usually polygenic and provides a more stable, though often lower, level of protection than race-specific traits. Because it does not target a single virulence gene, it is durable over long periods.

100. (A) Both A and R are true and R is the correct explanation of A.
Cultivars that rely on a single major gene for resistance frequently experience a "boom and bust" cycle because high selection pressure rapidly selects for virulent biotypes. As these biotypes overcome the resistance, the previously successful cultivar becomes obsolete and must be replaced. This cycle highlights the limitations of vertical resistance and the need for more complex, durable breeding strategies.

101. (A) Selecting for horizontal resistance or pyramiding multiple vertical genes
When breeding for a region with a history of rapid biotype evolution, breeders should prioritize selecting for horizontal resistance or pyramiding multiple vertical genes. These strategies provide more durable protection by making it much harder for the pest to overcome the plant's defenses. By diversifying the genetic basis of resistance, breeders can help ensure that new varieties remain effective.

102. (C) A single major gene
Monogenic resistance is defined as a trait that is controlled by a single major gene. This type of inheritance follows classic Mendelian patterns and is often relatively easy to identify and transfer into new crop varieties. However, because it relies on only one gene, it is also highly susceptible to being overcome by the evolution of virulent insect biotypes.

103. (A) A few genes whose individual effects are significant and measurable
Oligogenic resistance is governed by a few genes, each of which has a significant and measurable effect on the plant's level of defense. This pattern of inheritance provides a more complex and potentially more durable form of resistance than monogenic traits. Breeders often target oligogenic resistance because it offers a balance between ease of selection and stability against evolving populations.

104. (D) It involves many genes with small individual effects, making phenotypic selection and introgression complex.
Polygenic resistance is difficult to transfer into elite cultivars because it involves many genes, each with a small individual effect. This makes phenotypic selection and the process of introgression highly complex and time-consuming for breeders. Additionally, the additive nature of these genes means that losing even a few during the breeding process can significantly reduce the overall level of resistance.

105. (A) P-2, Q-4, R-1, S-3
Monogenic inheritance is controlled by a single major gene, while oligogenic traits involve a few major genes. Polygenic resistance is the result of many genes with small additive effects working together. Cytoplasmic inheritance is unique because it is transmitted exclusively through maternal organelles like mitochondria and chloroplasts. Each of these patterns requires a different approach for successful utilization in breeding.

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106. (C) 3:1
In an F2 segregating population for a single dominant resistance gene, a phenotypic ratio of three resistant plants to one susceptible plant is expected. This classic Mendelian ratio reflects the random assortment and combination of alleles from the parents. Observing this ratio during screening helps breeders confirm that the resistance trait is monogenic and dominant, simplifying the variety development process.

107. (D) Polygenic inheritance
Quantitative traits in host plant resistance are typically associated with polygenic inheritance, where the phenotype is determined by the combined action of many genes. These traits show continuous variation in the population and are often significantly influenced by environmental factors. Understanding the polygenic nature of quantitative resistance is essential for using advanced breeding techniques like QTL mapping to identify relevant genes.

125. (D) P-4, Q-3, R-1, S-2
Cry1Ac is a crystalline endotoxin effective against lepidopteran larvae, while Vegetative Insecticidal Proteins (VIPs) are secreted during the vegetative growth phase of Bt. Plant lectins are carbohydrate-binding proteins that disrupt digestion, and RNAi works by targeting specific mRNA to silence essential insect genes. Each of these biotechnological tools offers a unique mechanism for enhancing host plant resistance to pests.

126. (B) They are secreted during the vegetative growth phase and target different midgut receptors.
Vegetative Insecticidal Proteins (VIPs) differ from classical Cry proteins because they are secreted by the bacterium during its vegetative growth phase rather than during sporulation. Additionally, VIPs target different receptors in the insect midgut, making them effective against pests that have developed resistance to Cry proteins. Stacking both types of toxins in a single variety is a key resistance management strategy.

127. (A) They act by physically dissolving the insect's exterior cuticle.
Plant lectins do not act by physically dissolving the insect's exterior cuticle. Instead, they are carbohydrate-binding proteins that interfere with the herbivore's digestion by binding to the peritrophic matrix or midgut epithelial cells. This mechanism makes them effective against various sap-sucking insects and provides a different mode of action compared to Bt toxins, increasing the diversity of available resistance tools.

128. (C) Toxicity requires specific midgut receptors and alkaline conditions that are absent in humans.
Bt Cry proteins are toxic to specific insect larvae but harmless to humans because their activation requires both an alkaline environment and specific midgut receptors. Human stomachs are highly acidic, which rapidly denatures the proteins, and we lack the specialized receptors needed for the toxin to bind to cells. This biological specificity ensures that Bt crops remain safe for human consumption.

129. (D) Delay the evolution of insect resistance by targeting two different midgut receptors simultaneously.
Pyramiding a Cry gene and a Vip gene in a single transgenic crop is primarily done to delay the evolution of insect resistance. Because these two types of proteins target different receptors in the insect's midgut, a pest would need to develop multiple mutations simultaneously to survive. This dual-action approach significantly extends the durability and effectiveness of transgenic technology in the field.

130. (C) Double-stranded RNA (dsRNA) complementary to a vital insect gene
RNA interference (RNAi) as a tool for host plant resistance is based on the plant expressing double-stranded RNA (dsRNA) that is complementary to a vital insect gene. When the insect feeds on the transgenic plant, it ingests this dsRNA, which then triggers a sequence-specific silencing of the target gene's expression. This technology allows for highly precise and selective pest control.

131. (B) Small interfering RNAs (siRNAs) that guide the degradation of the target messenger RNA (mRNA)
Upon ingestion, plant-derived double-stranded RNA is processed by the insect's cellular machinery into small interfering RNAs (siRNAs). These siRNAs guide the degradation of the corresponding messenger RNA (mRNA) within the insect's cells. By preventing the translation of essential proteins, the RNAi process effectively silences the target gene, leading to the death or severe impairment of the feeding herbivore.

132. (D) The post-transcriptional silencing of genes essential for insect survival or development
The ultimate mechanism of mortality or stunting caused by RNAi is the post-transcriptional silencing of genes that are essential for the insect's survival or development. This process prevents the production of critical proteins, leading to a breakdown of vital biological functions. Because RNAi is based on genetic sequences, it can be tailored to target only specific pest species in agriculture.

133. (A) Allowing selection of resistance traits based on linked DNA markers rather than relying solely on phenotypic pest screening.
Marker-Assisted Selection (MAS) accelerates the breeding of resistant varieties by allowing

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the resulting plants are genetically identical, the resistance they possess is consistent across the entire population, making them highly reliable for use in commercial agricultural production.

117. (A) Self-pollinated crops, where detailed records of ancestry are maintained through segregating generations.
The pedigree method of breeding is most typically applied to self-pollinated crops where detailed records of ancestry are maintained through several segregating generations. This allows breeders to track the inheritance of resistance genes and other important traits from the original parents. By carefully selecting superior individuals in each generation, researchers can effectively combine multiple desired characteristics into one cultivar.

118. (C) It efficiently transfers complex polygenic resistance traits without linkage drag.
The statement that the backcross method efficiently transfers complex polygenic resistance traits is incorrect. Backcrossing is primarily used to transfer a single major gene into an otherwise elite and adapted cultivar. Because polygenic traits involve many genes with small effects, they are much harder to maintain and track through multiple generations of backcrossing without losing significant portions of overall resistance.

119. (A) The use of physical or chemical mutagens to create novel genetic variation not present in the germplasm.
Mutation breeding relies on the use of physical or chemical mutagens to create novel genetic variation not present in existing germplasm. This approach can be used to induce new resistance alleles in a crop that lacks effective defenses. While the process is random, it has successfully produced many resistant varieties in a wide range of important agricultural crops globally.

120. (D) Undesirable agronomic traits physically linked to the target resistance gene on the chromosome are transferred simultaneously.
Linkage drag is a significant challenge when introgressing resistance genes from wild relatives because undesirable agronomic traits physically linked to the target gene are often transferred simultaneously. These unwanted traits can negatively affect the yield or quality of the resulting variety. Breeders must perform multiple generations of backcrossing to break these links and recover the high-performing background of the parent.

121. (B) Supply the vast majority of the desired agronomic and yield characteristics of the final variety.
In a backcross breeding program, the primary role of the recurrent parent is to supply the vast majority of the desired agronomic and yield characteristics of the final variety. The recurrent parent is typically an elite, high-performing cultivar only lacking the specific resistance gene. Through repeated crossing, the plant's genome is restored to its high-quality state while retaining defense.

122. (C) Possession of a strong, identifiable, and usually simply inherited resistance trait.
The donor parent in a backcross breeding program is carefully selected based on its possession of a strong, identifiable, and usually simply inherited resistance trait. This parent provides the specific gene or genes that will be moved into the recurrent parent's genetic background. The success of the program depends on the donor's ability to consistently pass this resistance during hybridization.

123. (D) Crystalline delta-endotoxins
Bacillus thuringiensis (Bt) Cry proteins are formally classified as crystalline delta-endotoxins. These proteins are produced by the bacterium during sporulation and are highly toxic to specific groups of insects, particularly those in the order Lepidoptera. Their use in transgenic crops has revolutionized agricultural pest management by providing a built-in defense that is both highly effective and environmentally selective for growers.

NODIA

124. (A) Activation in the alkaline midgut, binding to specific receptors, and pore formation in the epithelial cell membrane.
The fundamental mode of action of Bt Cry proteins involves their activation in the alkaline environment of the insect's midgut. Once activated, the toxins bind to specific receptors on the surface of epithelial cells and form pores in the cell membrane. This leads to the disruption of the digestive system, causing the insect to stop feeding and eventually die.

108. (A) Recessive resistance genes cannot provide effective field-level protection.
A common misconception is that recessive resistance genes cannot provide effective field-level protection. In reality, many successful resistant varieties rely on recessive genes, which can be just as effective as dominant ones when present in a homozygous state. Breeders must simply use appropriate selection methods to ensure these genes are correctly incorporated and expressed in the final commercial cultivar.

109. (B) It ensures an adequate, uniform, and precisely timed supply of insects for artificial infestation.
Mass rearing of an insect pest is a critical prerequisite for evaluating host plant resistance because it ensures an adequate, uniform, and precisely timed supply of insects. This allows researchers to perform artificial infestations with consistent pest pressure across all test plants. Without a reliable source of insects, screening results can be inconsistent and difficult to interpret during breeding.

110. (B) Ensure uniform pest pressure, avoiding escapes that occur in natural field settings.
The primary purpose of artificial infestation in greenhouse screening is to ensure uniform pest pressure and prevent susceptible lines from escaping damage. In natural field settings, pest distribution is often uneven, which can lead to "escapes" that are mistaken for resistant plants. The controlled environment allows for a more accurate and reliable assessment of the plant's true genetic resistance.

111. (A) Evaluate the plant's resistance under realistic agronomic and environmental conditions.
Field screening layouts provide the advantage of evaluating a plant's resistance under realistic agronomic and environmental conditions. This includes exposure to natural pest populations, fluctuating weather, and the presence of competing insects and natural enemies. These factors are essential for confirming that the resistance observed in the laboratory or greenhouse will remain effective and stable in real-world farming.

112. (C) Reliance solely on natural, highly unpredictable windborne pest infestations
Greenhouse screening does not rely on natural and unpredictable windborne infestations. Instead, it utilizes artificial infestation with mass-reared insects to ensure controlled and consistent pest pressure. Other standard components include environmental control systems for temperature and photoperiod, as well as the use of cages to confine the insects and prevent them from escaping into the surrounding environment during testing.

113. (D) Allow quantitative comparison of resistance levels across different years, locations, and breeding programs.
Standardized damage scoring scales are used globally to allow for the quantitative comparison of resistance levels across different years, locations, and breeding programs. By using a common language to describe insect injury, researchers can reliably share data and identify promising resistant lines. These scales are essential for maintaining consistency and accuracy in the large-scale screening efforts required for breeding.

114. (D) High susceptibility resulting in complete plant death or "hopperburn"
In the Standard Evaluation System for rice against the brown planthopper, a score of '9' signifies high susceptibility, typically resulting in complete plant death or "hopperburn." This score represents the maximum level of damage and serves as a benchmark for comparing performance. Plants with lower scores exhibit various degrees of resistance, ranging from slight injury to high resistance.

115. (A) Both A and R are true and R is the correct explanation of A.
Field screening for resistance is often supplemented with greenhouse screening because the latter allows for more controlled and uniform pest pressure. This combination ensures that potential resistant lines are thoroughly tested and that susceptible plants do not escape infestation due to uneven pest distribution common in the field. Together, these methods provide a robust way to evaluate resistance.

116. (D) Selecting and isolating the superior progeny of a single self-pollinated homozygous resistant plant.
Pureline selection involves selecting and isolating the superior progeny of a single, self-pollinated, homozygous resistant plant. This conventional breeding approach is used to develop uniform and stable varieties with desired traits. Because

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researchers to select for defensive traits using linked DNA markers. This method eliminates the need to rely solely on time-consuming phenotypic screening during early selection stages. By identifying the presence of resistance genes directly in the plant's DNA, breeders can more quickly and accurately develop high-performing resistant cultivars.

134. (C) It replaces the need for any final phenotypic field testing before commercial release.
It is false to say that Marker-Assisted Selection replaces the need for any final phenotypic field testing. While MAS is highly effective for identifying and stacking genes, final field trials are still essential to confirm the resistance level and agronomic performance before commercial release. These trials ensure that the resistance remains effective under real-world conditions and meets yield standards.

135. (A) To confirm the presence of the specific target resistance gene(s) from the donor parent
In a MAS backcrossing program, foreground selection is used to confirm the presence of specific target resistance genes from the donor parent. By using molecular markers tightly linked to these genes, breeders can quickly identify which offspring inherited the desired defensive trait. This step is crucial for ensuring the target gene is successfully maintained throughout the multi-generational breeding process.

136. (A) Identify the chromosomal regions that contribute to a complex, polygenically inherited resistance trait.
Quantitative Trait Loci (QTL) mapping is fundamentally used to identify the specific chromosomal regions that contribute to a complex, polygenically inherited resistance trait. By linking phenotypic variation to molecular markers across the genome, researchers can locate the genes responsible for defense. This information is essential for using marker-assisted selection to stack multiple minor genes into a single durable cultivar.

137. (B) A mutation modifying the midgut epithelial proteins so the Cry toxin can no longer bind.
Altered receptor binding is a major mechanism of insect resistance to Bt crops, involving mutations that modify the proteins in the insect's midgut epithelium. These changes prevent the Cry toxins from successfully binding to the cell surface, nullifying their toxic effect. This form of resistance is specific to a particular toxin, making the use of diverse toxins essential for management.

138. (C) Cytochrome P450 monooxygenases, esterases, and glutathione S-transferases
Metabolic detoxification as a resistance mechanism is associated with the upregulation of several key enzyme families in the insect, including cytochrome P450 monooxygenases, esterases, and glutathione S-transferases. These enzymes break down or neutralize plant defensive chemicals before they can cause physiological harm. The ability to detoxify diverse allelochemicals is a primary way that generalist herbivores adapt to host defenses.

139. (C) An insect resistant to a Bt toxin automatically becomes resistant to all organophosphate chemical insecticides.
The statement that an insect resistant to a Bt toxin automatically becomes resistant to all organophosphate chemical insecticides is incorrect. Cross-resistance typically occurs between toxins that share a common mode of action or binding site, which is not the case for Bt and organophosphates. Understanding specific patterns of cross-resistance is vital for planning effective strategies that utilize diverse control methods.

NODIA

140. (A) It prevents the allelochemical from binding to its intended physiological receptor, nullifying the toxic effect.
A target site mutation provides an advantage to the insect by preventing an allelochemical from binding to its intended physiological receptor. This nullifies the toxic effect of the plant's defense without requiring the insect to actively detoxify the chemical. Such mutations are common in the evolution of resistance to both natural plant defenses and synthetic pesticides in agricultural systems.

141. (B) Detect early shifts in allele frequencies for resistance before field control failure occurs.
Routine resistance monitoring is conducted to detect early shifts in allele frequencies for resistance within field populations before actual control failure occurs. By identifying these changes early, agriculturalists can adjust management strategies to slow the development of resistance. This proactive monitoring is a critical

part of ensuring the long-term sustainability and effectiveness of resistant crop varieties and pest control.

142. (B) A genetically stable decrease in susceptibility to a toxin has occurred in a wild pest population, often leading to reduced control efficacy.
A case of "field evolved resistance" implies that a genetically stable decrease in susceptibility to a toxin has occurred in a wild pest population, often leading to reduced control efficacy. This phenomenon is a direct result of selection pressure exerted by the widespread use of a specific resistance trait. Documenting these cases is essential for understanding pest evolutionary dynamics.

143. (A) Using a high toxin dose to kill heterozygotes and a refuge to produce susceptible mates.
The high-dose/refuge strategy is based on using a high toxin dose to kill nearly all insects, including those with a single resistance allele. The refuge area consists of non-toxic plants that produce a large population of susceptible insects to mate with any rare survivors from the toxic field. This approach keeps the resistance alleles rare and slows overall evolution.

144. (C) Combining multiple transgenes (e.g., insect resistance and herbicide tolerance) into a single crop variety.
In transgenic crop management, 'stacked traits' refer to the combination of multiple transgenes into a single crop variety. These can include multiple genes for insect resistance with different modes of action, as well as genes for herbicide tolerance or other beneficial characteristics. Stacking traits is a powerful way to enhance the overall performance and durability of a commercial variety.

145. (D) Larval movement between adjacent toxic and non-toxic plants can lead to sub-lethal exposure and accelerate resistance.
A potential risk of the "refuge in a bag" strategy is that larval movement between adjacent toxic and non-toxic plants can lead to sub-lethal exposure. This exposure may allow insects with partial resistance to survive and reproduce, thereby accelerating the evolution of resistance. Researchers must carefully consider the behavior of target pests to minimize the risk of such consequences.

146. (C) Genetic Engineering Appraisal Committee (GEAC)
In India, the Genetic Engineering Appraisal Committee (GEAC) is the primary regulatory body responsible for the approval and environmental release of genetically engineered crops. Operating under the Ministry of Environment, Forest and Climate Change, the GEAC evaluates the biosafety and environmental impact of transgenic varieties before they can be commercialized. This rigorous process ensures new technologies are safe.

147. (B) It is biologically essential to delay the development of insect resistance, preserving the long-term utility of the transgenic technology.
Strict regulatory compliance with refuge requirements is mandated because it is biologically essential to delay the development of insect resistance and preserve the long-term utility of transgenic technology. Refuges provide a source of susceptible individuals that dilute resistance alleles in the pest population. Without effective refuge management, selection pressure would quickly lead to widespread resistance, rendering the technology useless.

148. (D) Structured refuge to maintain a population of susceptible bollworms
Planting a percentage of non-Bt cotton around the field perimeter acts as a structured refuge designed to maintain a population of susceptible bollworms. These susceptible individuals mate with any rare resistant insects that might survive in the Bt field, preventing resistance from becoming fixed in the next generation. This strategy is a key component of insect resistance management programs.

149. (A) The deployment of a series of major designated H genes conferring strong antibiosis.
The historical success of breeding wheat resistant to the Hessian fly relies heavily on the deployment of a series of major H genes that confer strong antibiosis. These genes have been identified and introgressed into many successful cultivars, providing a powerful means of reducing damage and controlling fly populations. This effort serves as a model for vertical resistance breeding.

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150. (C) The sequential emergence of multiple Hessian fly biotypes capable of overcoming specific H genes.
A major consequence of utilizing single H genes for Hessian fly resistance has been the sequential emergence of multiple biotypes capable of overcoming specific genes. As each new gene was widely deployed, it exerted intense selection pressure on the fly population, leading to rapid development of virulence. This ongoing evolutionary battle necessitates the continuous discovery and deployment of new genes.

151. (A) Non-preference for oviposition driven by specific morphological and chemical traits.
Resistance to the sorghum shoot fly is primarily attributed to non-preference for oviposition, which is driven by a combination of morphological and chemical traits. These features make the sorghum plant less attractive to the female fly during the egg-laying phase, thereby reducing the initial infestation level. This antixenosis mechanism is a key target for breeding resilient sorghum varieties.

152. (B) Glossy leaf trait
The glossy leaf trait is a morphological feature in sorghum that is strongly correlated with resistance to the shoot fly. Plants with this trait have a characteristic appearance due to a different wax structure on the leaf surface, which interferes with the insect's ability to navigate and lay eggs. Selecting for the glossy trait is a common breeding strategy.

153. (B) Jassid resistance is achieved by utilizing varieties with entirely glabrous (hairless) leaves.
The statement that cotton jassid resistance is achieved by utilizing entirely glabrous (hairless) leaves is incorrect. Resistance is fundamentally linked to the presence of long and dense trichomes on the leaf surface, which provide a physical barrier. Glabrous varieties are more susceptible to jassid damage because they lack the structural features that interfere with insect feeding.

154. (C) Long, dense, and erect trichomes on the leaf lamina and midrib
In breeding for cotton jassid resistance, agronomists should select lines that exhibit long, dense, and erect trichomes on the leaf lamina and midrib. These physical structures prevent the jassid from effectively inserting its stylets into the leaf veins to feed on sap. This morphological defense is a highly effective and stable form of resistance incorporated into many commercial cotton varieties.

155. (D) Major dominant and recessive Bph genes conferring strong antibiosis and antixenosis.
Resistance to the brown planthopper (BPH) in rice is classically characterized by the integration of several major Bph genes that confer both antibiosis and antixenosis. These genes work together to negatively affect insect biology and behavior, providing a high level of protection. This genetic diversity is essential for developing varieties resilient to the diverse and evolving populations of BPH.

156. (A) It was rapidly overcome by the emergence of BPH Biotype 2 within a few years of release.
The major limitation encountered with the release of rice varieties containing the Bph1 gene was that resistance was rapidly overcome by the emergence of BPH Biotype 2. Within a few years of widespread cultivation, the new biotype became dominant, rendering previously resistant varieties susceptible. This event highlighted the challenges of using single major genes for sustainable pest control.

NODIA

157. (B) GLH is the principal vector for transmitting the destructive Rice Tungro Virus disease.
Resistance to the green leafhopper (GLH) in rice is agronomically vital primarily because the insect is the principal vector for transmitting the destructive Rice Tungro Virus disease. By reducing the GLH population or preventing it from feeding on the crop, resistant varieties can significantly lower the incidence of the virus. This indirect disease control is key for production.

158. (B) Vector avoidance or deterrence (antixenosis/ antibiosis) disrupting the virus transmission cycle.
Breeding for resistance to the green leafhopper subsequently results in field-level protection against Rice Tungro Virus by disrupting the virus transmission cycle. This is an example of disease control through vector avoidance or deterrence, where the plant's defense against the insect prevents the virus from being introduced. This strategy emphasizes ecological links between pests and the diseases they carry.

antennae, enhancing chemoreceptor sensitivity.

2004

24. A bait containing hydrolysed protein is typically classified under which category of chemical ecology tools?
(A) Oviposition lure
(B) Synthetic sex pheromone
(C) Food attractant
(D) Alarm semiochemical

2024

25. Select the correct sequential order of insect behavioral responses as they navigate toward an attractant-baited trap.
(A) Activation → Upwind oriented flight → Visual orientation → Landing/Capture
(B) Upwind oriented flight → Visual orientation → Activation → Landing/Capture
(C) Visual orientation → Activation → Upwind oriented flight → Landing/Capture
(D) Landing/Capture → Upwind oriented flight → Visual orientation → Activation

2023

26. Which botanical compound is recognized primarily for its role as an oviposition lure rather than a feeding deterrent for specific specialist pests?
(A) Sinigrin (a glucosinolate) for the cabbage white butterfly
(B) Azadirachtin from neem
(C) Limonin from citrus
(D) Pyrethrin from Chrysanthemum

2011

27. What is a primary distinction between physical and chemical insect repellents?
(A) Physical repellents are strictly volatile compounds, whereas chemical repellents are always applied as solid dusts.
(B) Physical repellents act via tactile irritation while chemical ones target receptors
(C) Physical repellents are only effective against adult insects, whereas chemical repellents target only larval stages.
(D) Physical repellents invariably kill the insect upon contact, whereas chemical repellents only kill upon ingestion.

2010

28. Which of the following synthetic chemical repellents is widely regarded as the gold standard for protecting humans against mosquitoes and ticks?
(A) Azadirachtin
(B) N,N-Diethyl-meta-toluamide (DEET)
(C) Methoprene
(D) Diflubenzuron

2003

29. Picaridin is a popular alternative to DEET. What is a distinct advantage of picaridin over DEET in consumer applications?
(A) Picaridin is less likely to degrade synthetic fabrics and plastics upon contact.
(B) Picaridin has a highly pungent, undesirable odor that deters pests more effectively.
(C) Picaridin acts simultaneously as a potent systemic insecticide in humans.
(D) Picaridin strictly functions as a spatial repellent without requiring topical application.

2022

30. Consider the following statements concerning botanical insect repellents:
I. Citronella exhibits high volatility, resulting in short-term protective efficacy.
II. Neem extracts function exclusively as repellents and lack any antifeedant properties.
III. Botanical repellents generally require more frequent reapplication compared to synthetics like DEET.
IV. Botanical formulations never cause allergic contact dermatitis in sensitive individuals.
V. Essential oils frequently disrupt insect olfactory receptor functioning.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) II, III, IV and V
(C) I, III and V
(D) I, III, IV and V

2019

31. Citronellal, the main active component in citronella oil, primarily targets which specific sensory system in mosquitoes to exert its repellent effect?
(A) Auditory mechanoreceptors
(B) Proprioceptive organs
(C) Photoreceptors in the ommatidia
(D) Olfactory receptor neurons

2005

32. Insect antifeedants (feeding deterrents) generally act by interacting with which physiological structure on the insect's body?
(A) Auditory tympanal organs on the abdomen

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CHAPTER 08
Innovative Approaches in Pest Control

2013

1. Which of the following best defines semiochemicals in the context of chemical ecology?
(A) Chemicals that mediate interactions only between members of the same species
(B) Chemicals secreted to the external environment that mediate interactions between organisms
(C) Internal hormones regulating moulting and metamorphosis within a single organism
(D) Synthetic chemicals utilized strictly for the mass trapping of agricultural insect pests

2016

2. Among allelochemicals, which classification specifically refers to a chemical substance emitted by one species that evokes a response highly advantageous to the receiver but detrimental to the emitter?
(A) Allomone
(B) Synomone
(C) Apneumone
(D) Kairomone

2002

3. Identify the INCORRECT statement regarding the hierarchical classification of semiochemicals.
(A) Synomones benefit the emitting organism but negatively affect the receiving organism.
(B) Pheromones are intraspecific semiochemicals.
(C) Allelochemicals are interspecific semiochemicals.
(D) Apneumones are substances derived from non-living material that elicit behavioral responses.

2003

4. Which of the following interactions most accurately illustrates the concept of a synomone?
(A) A predator emitting a scent that deters a competitor from the same guild
(B) An insect releasing a sex attractant to locate a suitable mate over long distances
(C) A plant emitting volatile compounds when attacked by an herbivore, attracting parasitoids
(D) A dead organism releasing odors that attract necrophagous insects for oviposition

2005

5. Consider the following statements regarding allomones and their role in chemical ecology:
I. They are a distinct subclass of allelochemicals.
II. They provide an adaptive advantage to the receiver while harming the emitter.
III. They mediate interactions between individuals of different species.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I

2025

6. A volatile compound released by a host plant allows an oligophagous herbivore to easily locate it. In evolutionary terms, what is the most likely reason the plant has not completely suppressed the emission of this compound?
(A) The compound is fundamentally an allomone designed to kill the herbivore.
(B) The plant uses the compound to warn conspecific plants, outweighing herbivore damage.
(C) The plant's metabolic pathways are entirely unregulated by natural selection.
(D) The compound serves primary metabolic functions essential for the plant's survival.

2021

7. Epideictic pheromones are primarily utilized by insects to achieve which of the following ecological outcomes?
(A) Coordinated mass attack on a single resistant host plant
(B) Assessment of resource exploitation to ensure adequate spacing
(C) Attraction of the opposite sex for the purpose of copulation
(D) Rapid dispersal in response to a threatening predator

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2025

8. What is the fundamental difference between aggregation pheromones and sex pheromones?
(A) Aggregation pheromones attract only females, while sex pheromones attract only males.
(B) Aggregation pheromones are highly volatile, whereas sex pheromones are non-volatile contact cues.
(C) Aggregation pheromones attract both sexes, whereas sex pheromones typically attract one specific sex.
(D) Aggregation pheromones function solely in defense, whereas sex pheromones facilitate reproduction.

2008

9. Trail pheromones in social insects such as ants and termites are most commonly associated with which glandular origin?
(A) Corpora cardiaca
(B) Prothoracic gland
(C) Corpora allata
(D) Dufour's gland or sternal glands

2018

10. Given below are two statements, one labelled as Assertion (A) and the other as Reason (R).
Assertion (A): Alarm pheromones in aphids cause immediate dispersal behavior and dropping from the host plant.
Reason (R): Alarm pheromones are heavy, low-volatility molecules designed to persist in the environment for extended periods.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2013

11. Which group of insects is most widely noted for the production of (E)-beta-farnesene as an alarm pheromone?
(A) Formicidae (Ants)
(B) Aphididae (Aphids)
(C) Apidae (Bees)
(D) Termitidae (Termites)

2023

12. In the application of mating disruption techniques for pest management, which outcome indicates a successful deployment of the confusion strategy?
(A) Increased male mortality directly caused by the pheromone formulation
(B) A significant reduction in the frequency of successful copulations
(C) Sensitization of male olfactory receptors leading to hyper-activity
(D) Aggregation of both male and female pests in designated trap zones

2013

13. Which of the following best describes the physiological mechanism underlying the lure-and-kill (attracticide) behavioral control strategy?
(A) Combining a semiochemical attractant with a toxicant to eliminate the responding insects
(B) Modifying the genetic makeup of the attracted insects to cause delayed mortality
(C) Utilizing sterile males to attract wild females into physical retention devices
(D) Saturating the crop environment with a repellent that starves the pest population

2013

14. Mass trapping is generally most effective in reducing pest population density when applied under which of the following ecological conditions?
(A) At high initial pest population densities in open, homozygous field environments
(B) Exclusively during the larval developmental stages of the target insect pest
(C) At low initial pest population densities in relatively isolated or enclosed ecosystems
(D) When utilizing solely epideictic pheromones inside highly ventilated greenhouses

2001

15. Match the insect behavioral control strategies in List I with their primary operational mechanisms in List II.
List I: (Control Strategy)
P. Mass trapping
Q. Mating disruption
R. Attracticide
S. Push-pull strategy
List II: (Operational Mechanism)
1. Combines a semiochemical lure with an insecticide
2. Removes a large proportion of individuals from the population using physical traps
3. Uses repellents to drive pests away and attractants to lure them into traps
4. Permeates the air with synthetic sex pheromones to prevent mate location
(A) P-2, Q-4, R-1, S-3
(B) P-4, Q-2, R-1, S-3

NODIA

(C) P-2, Q-1, R-4, S-3
(D) P-3, Q-4, R-1, S-2

2022

16. What is the primary disadvantage of using capillary tube dispensers for pheromone field applications compared to microencapsulated formulations?
(A) Capillary tubes release pheromones at a highly variable rate dependent solely on humidity.
(B) Capillary tubes chemically degrade the active pheromone compound within hours.
(C) Capillary tubes cannot be deployed using standard liquid agricultural spraying equipment.
(D) Capillary tubes attract non-target natural enemies at a significantly higher frequency.

2008

17. The trapping efficiency of a pheromone-baited trap is LEAST likely to be influenced by which of the following environmental or design parameters?
(A) The aerodynamic shape and specific placement height of the physical trap
(B) The nutritional status of the host plant beneath the trap
(C) The release rate profile and longevity of the specific pheromone dispenser used
(D) The ambient temperature and prevailing wind velocity profiles in the field

2005

18. Identify the INCORRECT pairing of a pheromone dispenser type and its defining characteristic.
(A) Rubber septa - Releases pheromones slowly by diffusion through an elastomeric matrix
(B) Hollow fibers - Pheromone evaporates from an open meniscus within a capillary system
(C) Microencapsulation - Encloses pheromone droplets in a polymer wall for spray application
(D) PVC matrices - Binds pheromones covalently to prevent all environmental degradation

2001

19. A delta trap is commonly preferred in agricultural settings for monitoring lepidopteran pests because of its specific design feature. What is this feature?
(A) It shields the sticky surface from dust and water
(B) It utilizes a water basin to drown the attracted pests
(C) It relies on visual attraction without any chemical lure
(D) It uses air pumps to expand the pheromone plume volume

2014

20. Consider the following statements regarding the mechanisms of mating disruption in insect pests:
I. False trail following occurs when males waste time pursuing artificial pheromone sources.
II. Sensory fatigue involves the downregulation of olfactory receptors due to continuous exposure.
III. Camouflage prevents males from distinguishing the female's pheromone plume from background levels.
IV. Mating disruption universally kills the female insects prior to oviposition.
Which of the above statement(s) is/are INCORRECT?
(A) I and II
(B) III and IV
(C) I, II and IV
(D) IV

2018

21. Which non-pheromone attractant relies primarily on emitting volatiles that mimic decomposing organic matter or microbial fermentation?
(A) Food and feeding lures
(B) Visual synergists
(C) Sex attractants
(D) Oviposition repellents

2017

22. In the management of Tephritid fruit flies, methyl eugenol functions strictly as which type of behavioral modifier?
(A) Female-specific oviposition deterrent
(B) Broad-spectrum contact insecticide
(C) Epideictic spacing semiochemical
(D) Male-specific parapheromone attractant

2003

23. Visual synergists are often combined with olfactory lures in pest management to maximize trap catches. Which of the following best explains this synergistic effect?
(A) Visual cues change the chemical structure of the olfactory lure to make it more volatile.
(B) Insects use olfactory cues for navigation and visual cues for targeting
(C) Visual synergists emit heat that artificially accelerates the vaporization of the lure.
(D) Visual cues directly bind to the insect's

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159. (A) Gall midge resistance is highly stable, with no biotypes ever recorded.
The statement that gall midge resistance is highly stable with no biotypes ever recorded is incorrect, as several virulent biotypes have been documented across different regions. Resistance is actually governed by a series of major Gm genes, and the emergence of new biotypes remains a significant challenge. Understanding regional variation in gall midge populations is essential for effective resistance deployment.

160. (C) Delay the emergence of new, virulent gall midge biotypes.
Agronomists use the strategy of gene pyramiding for gall midge resistance to delay the emergence of new and virulent biotypes. By incorporating multiple Gm genes into a single rice variety, they make it much more difficult for the insect to overcome plant defenses. This approach provides durable protection, ensuring long-term stability of rice production in areas where the pest is endemic.

****

NODIA

(B) Excretory Malpighian tubules
(C) Gustatory sensilla on the mouthparts and tarsi
(D) Reproductive accessory glands

2008

33. The triterpenoid azadirachtin is recognized as one of the most potent insect antifeedants. What is an additional major physiological effect it exerts on insect pests?
(A) It stimulates rapid, uncontrolled hyper-excitability leading to paralysis.
(B) It disrupts the endocrine system, specifically altering ecdysone levels and moulting.
(C) It acts as a powerful sex pheromone mimic, causing severe mating disruption.
(D) It forces premature pupation within twenty-four hours of initial contact.

2022

34. Limonin, a compound extracted from citrus, is heavily utilized due to its antifeedant activity primarily against which insect pest?
(A) Cotton bollworm (Helicoverpa armigera)
(B) Desert locust (Schistocerca gregaria)
(C) Fall armyworm (Spodoptera frugiperda)
(D) Colorado potato beetle (Leptinotarsa decemlineata)

2024

35. Given below are two statements, one labelled as Assertion (A) and the other as Reason (R).
Assertion (A): Synthetic chemical antifeedants frequently fail in long-term field applications due to insect habituation.
Reason (R): Insects can neurologically adapt to several deterrents, eventually ignoring the sensory signal.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2008

36. From a chemical ecology perspective, how does an antifeedant differ fundamentally from an attracticide?
(A) An antifeedant actively lures insects to a toxic source while an attracticide repels them from the target crop
(B) An antifeedant alters mating behavior while an attracticide primarily targets larval feeding and development
(C) An antifeedant prevents food ingestion; attracticides lure then kill the pest
(D) An antifeedant is strictly synthetic while an attracticide is always botanically derived for environmental safety

2005

37. Which of the following correctly describes the anatomical location and function of the corpora allata in an insect's endocrine system?
(A) Located behind the brain; synthesizes and secretes juvenile hormone (JH)
(B) Located in the abdomen; synthesizes prothoracicotropic hormone (PTTH)
(C) Located in the thorax; synthesizes and secretes ecdysone
(D) Located in the midgut; synthesizes digestive enzymes required for moulting

2005

38. The prothoracic gland is directly stimulated to produce ecdysteroids by which of the following neuropeptides?
(A) Allatostatin
(B) Bursicon
(C) Eclosion hormone
(D) Prothoracicotropic hormone (PTTH)

2003

39. During the larval-to-pupal metamorphosis in holometabolous insects, which specific hormonal balance is required?
(A) High titer of juvenile hormone alongside high ecdysone
(B) High titer of ecdysone in the complete absence of juvenile hormone
(C) Low titer of both ecdysone and juvenile hormone simultaneously
(D) High titer of juvenile hormone in the complete absence of ecdysone

2009

40. Match the insect endocrine components in List I with their principal secretory products or functions in List II.
List I: (Endocrine Component)
P. Neurosecretory cells (pars intercerebralis)
Q. Corpora allata
R. Prothoracic gland
S. Corpora cardiaca
List II: (Product/Function)
1. Synthesizes Ecdysone
2. Stores and releases PTTH
3. Synthesizes PTTH
4. Synthesizes Juvenile Hormone (JH)

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(A) P-3, Q-4, R-1, S-2
(B) P-2, Q-1, R-4, S-3
(C) P-3, Q-2, R-1, S-4
(D) P-1, Q-4, R-3, S-2

2019

41. In the regulation of insect moulting, ecdysone is typically considered a prohormone. Which tissue is primarily responsible for converting ecdysone into its highly active form, 20-hydroxyecdysone?
(A) Corpora cardiaca
(B) Malpighian tubules
(C) Ventral nerve cord
(D) Fat body and epidermal cells

2006

42. Which phenomenon is characterized by the application of juvenile hormone (JH) analogs to late-instar larvae, preventing successful pupation and resulting in supernumerary (extra) larval instars?
(A) Morphogenetic disruption
(B) Premature lethal moulting
(C) Exocuticular melanization
(D) Autocidal sterilization

2018

43. Methoprene is primarily classified under which functional category of insect growth regulators (IGRs)?
(A) Ecdysone agonist
(B) Juvenile hormone (JH) analog
(C) Chitin synthesis inhibitor
(D) Anti-juvenile hormone

2006

44. Fenoxycarb is widely utilized in agriculture to control certain lepidopteran and hemipteran pests. What is its principal mode of action?
(A) It permanently binds to the ecdysone receptor, preventing normal moulting.
(B) It mimics juvenile hormone, keeping the pest in an immature, non-reproductive stage.
(C) It inhibits the enzyme chitin synthase, leading to cuticular failure.
(D) It destroys the corpora allata directly, removing all native hormones.

2005

45. Arrange the following sequence of endocrinological events during a standard insect larval moult in the correct order.
I. Release of PTTH from corpora cardiaca
II. Activation of brain neurosecretory cells to produce PTTH
III. Epidermal cells undergo apolysis and synthesize new cuticle
IV. Prothoracic gland secretes ecdysone
(A) II, I, IV, III
(B) I, II, III, IV
(C) II, IV, I, III
(D) IV, I, II, III

NODIA

2021

46. Pyriproxyfen is a potent insect growth regulator extensively used in public health for mosquito control. How does it effectively control mosquito populations?
(A) It acts as an adulticide, causing immediate paralysis upon contact.
(B) It repels female mosquitoes from locating aquatic oviposition sites.
(C) It prevents adult emergence from pupae by disrupting metamorphosis.
(D) It induces sterile mating strictly in adult male mosquitoes.

2023

47. Why are Juvenile Hormone (JH) analogs generally considered to have a highly favorable biosafety profile regarding human health?
(A) Vertebrates possess specialized enzymes that instantly degrade all JH analogs.
(B) JH analogs only function at extreme temperatures not found in mammals.
(C) The chemical structure of JH analogs is identical to human cholesterol.
(D) Vertebrates lack the specific intracellular receptors necessary for JH binding.

2011

48. Identify the primary characteristic of an anti-juvenile hormone compound (e.g., Precocenes) when applied to early instar insect larvae.
(A) It induces a supernumerary giant larval instar.
(B) It prevents the insect from ever initiating apolysis.
(C) It triggers precocious metamorphosis into miniature, sterile adults.
(D) It causes an overproduction of native juvenile hormone.

2008

49. Ecdysone agonists, such as tebufenozide, control insect pests through a very specific physiological disruption. What is the observable outcome of this disruption in targeted Lepidoptera?
(A) The indefinite prolongation of the larval feeding stage without any moulting attempts.
(B) The induction of a premature, lethal moult

where the insect cannot shed its old head capsule.
(C) The rapid melanization and hardening of the midgut lining, causing immediate starvation.
(D) The acceleration of adult emergence, leading to fertile but extremely small moths.

2009

50. Consider the following statements regarding Ecdysone agonists (MACs - Moulting Accelerating Compounds):
I. They bind selectively to the ecdysone receptor complex.
II. Methoxyfenozide is a well-known example of this group.
III. They lower ecdysteroid titers to zero to halt metamorphosis.
Which of the above statement(s) is/are correct?
(A) I and II
(B) III
(C) I and III
(D) II

2005

51. Which specific receptor complex is the direct target for ecdysone agonists like methoxyfenozide?
(A) EcR/USP (Ecdysone Receptor/ Ultraspiracle) heterodimer
(B) Acetylcholine receptor
(C) GABA-gated chloride channel
(D) Ryanodine receptor

2022

52. Benzoylureas, a major class of Insect Growth Regulators (IGRs), are primarily recognized for which specific biochemical mode of action?
(A) Binding aggressively to juvenile hormone esterase
(B) Preventing the secretion of prothoracicotropic hormone (PTTH)
(C) Inhibiting the synthesis of chitin in the insect cuticle
(D) Acting as potent competitive inhibitors of mitochondrial respiration

2014

53. Diflubenzuron causes insect mortality primarily at which distinct physiological event?
(A) During ecdysis, as the new cuticle cannot withstand muscular traction
(B) During the mating flight
(C) Immediately following ingestion, via gut paralysis
(D) During egg fertilization in the female reproductive tract

2013

54. Which life stage of an insect is generally the LEAST susceptible to the direct lethal effects of chitin synthesis inhibitors?
(A) First instar larvae
(B) Actively moulting nymphs
(C) Developing embryos within the egg
(D) Adult insects

2007

55. Given below are two statements, one labelled as Assertion (A) and the other as Reason (R).
Assertion (A): Chitin synthesis inhibitors are frequently applied as stomach poisons rather than contact insecticides.
Reason (R): These compounds must be ingested to effectively reach the epidermal cells where cuticle formation occurs.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2009

56. Alkylating agents represent a prominent class of chemosterilants. What is their fundamental mechanism of action at the cellular level?
(A) They physically block the micropyle of the insect egg.
(B) They substitute vital amino acids during translation in the ribosomes.
(C) They cross-link DNA strands to inhibit replication and cause mutations
(D) They destroy the insect's gut microbiome, leading to reproductive failure.

2008

57. TEPA and METEPA belong to which specific classification of insect chemosterilants?
(A) Antimetabolites
(B) Radiomimetic compounds
(C) Juvenile hormone mimics
(D) Alkylating agents

2024

58. How do antimetabolite chemosterilants, such as 5-fluorouracil, induce sterility in insect populations?
(A) By mimicking natural nucleosides, thereby interfering with normal nucleic acid synthesis
(B) By directly vaporizing the insect's reproductive organs via exothermic reactions
(C) By dissolving the chorion of developing eggs before oviposition

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(D) By emitting alpha radiation that destroys gametes

2007

59. What primary biosafety limitation drastically restricts the widespread agricultural field application of alkylating chemosterilants today?
(A) They are completely insoluble in all known agricultural solvents.
(B) They exhibit high mutagenicity, carcinogenicity, and toxicity to mammals and humans.
(C) They are highly volatile and destroy atmospheric ozone.
(D) They uniquely stimulate secondary pest outbreaks by killing only predators.

2003

60. Match the insect growth regulator/chemosterilant categories in List I with their specific chemical examples in List II.
List I: (Category)
P. Ecdysone agonist
Q. Chitin synthesis inhibitor
R. Juvenile hormone analog
S. Alkylating chemosterilant
List II: (Example)
1. Diflubenzuron
2. TEPA
3. Methoxyfenozide
4. Methoprene
(A) P-3, Q-1, R-4, S-2
(B) P-1, Q-3, R-2, S-4
(C) P-3, Q-4, R-1, S-2
(D) P-4, Q-2, R-3, S-1

2009

61. In the context of chemosterilant application, why are bait stations generally preferred over broadcast foliar sprays?
(A) Baits selectively target the pest while minimizing environmental contamination and exposure to non-targets.
(B) Baits prevent the active compound from rapidly degrading under exposure to ultraviolet solar radiation
(C) Broadcast sprays fail to effectively coat the undersides of leaves where insects congregate to mate
(D) Chemosterilants require an auxiliary sugar or protein matrix to undergo biological chemical activation

2007

62. Which classification of chemosterilants is named for its ability to produce biological effects nearly identical to those caused by ionizing radiation?
(A) Antimetabolites
(B) Chitin inhibitors
(C) Radiomimetic compounds
(D) Pheromone analogues

2009

63. What is the central premise of Autocidal control in insect pest management?
(A) Introducing foreign, exotic predators to eradicate a native pest species
(B) Genetically altering crop plants to produce self-acting toxins
(C) Utilizing synthetic pheromones to induce immediate suicide in adult males
(D) Manipulating the pest population so that its members contribute to the reduction or extinction of their own species

NODIA

2003

64. The Sterile Insect Technique (SIT) relies heavily on mass-rearing insects and sterilizing them before release. Which physiological stage is traditionally subjected to irradiation for operational efficiency?
(A) Early instar larvae
(B) Actively feeding adults
(C) Late pupae or newly emerged adults
(D) Freshly deposited eggs

2016

65. Consider the following statements regarding the biological constraints of the Sterile Insect Technique (SIT):
I. The target pest must ideally have a high natural population density that cannot be reduced.
II. Released sterile males must be able to compete successfully with wild males for mates.
III. The released sterile insects themselves must not cause significant economic damage to the crop.
IV. SIT is highly effective against pests that reproduce strictly via parthenogenesis.
Which of the above statement(s) is/are correct?
(A) I and IV
(B) II and III
(C) I, II and III
(D) II, III and IV

2013

66. Gamma radiation induces insect sterility primarily by causing which type of sub-cellular damage?
(A) Disruption of the myelin sheath in the ventral nerve cord
(B) Complete degradation of all gut digestive enzymes
(C) The physical fusion of the external copulatory organs
(D) Creation of dominant lethal mutations via chromosomal strand breaks

2006

67. The first truly monumental success of the Sterile Insect Technique (SIT) was the eradication of which devastating livestock pest from the United States?
(A) Screwworm fly (Cochliomyia hominivorax)
(B) Tsetse fly (Glossina palpalis)
(C) Mediterranean fruit fly (Ceratitis capitata)
(D) Melon fly (Bactrocera cucurbitae)

2018

68. The eradication of the screwworm fly using SIT was biologically feasible largely because of a specific reproductive trait of the female. What is this trait?
(A) Females reproduce parthenogenetically.
(B) Females lay only a single egg per host.
(C) Females typically mate only once during their lifetime.
(D) Females lack functional wings and cannot disperse.

2023

69. The Mediterranean fruit fly (Medfly) SIT programs often utilize Genetic Sexing Strains (GSS). What is the primary operational advantage of using GSS in SIT?
(A) It allows for the exclusive mass-release of sterile males, preventing damage by sterile females.
(B) It ensures the released insects are genetically identical to the wild type.
(C) It eliminates the need for any irradiation equipment.
(D) It makes the sterile insects highly resistant to all applied insecticides.

2003

70. Select the correct sequential order of operational phases in a classical Area-Wide Sterile Insect Technique (SIT) program.
I. Mass rearing
II. Sterilization
III. Field release
IV. Population monitoring
(A) I, II, III, IV
(B) III, IV, I, II
(C) II, I, III, IV
(D) IV, III, II, I

NODIA

2016

71. Chromosomal translocations can be utilized for advanced genetic control. How does a reciprocal translocation generally induce sterility or population reduction?
(A) By preventing the insect from locating a host plant.
(B) By causing unequal chromosome segregation leading to inviable zygotes
(C) By directly inhibiting the production of juvenile hormone.
(D) By causing rapid somatic cell necrosis in the adult insect.

2025

72. Release of Insects carrying a Dominant Lethal (RIDL) is a modern genetic control strategy. Which regulatory mechanism typically controls the expression of the lethal gene in the mass-rearing facility?
(A) A temperature-sensitive promoter requiring freezing conditions
(B) A photoperiod-sensitive switch requiring continuous darkness
(C) A chemical repressor system, usually involving dietary tetracycline
(D) An RNA-interference hairpin trigger that degrades upon release

2009

73. Which of the following is a key advantage of F1 sterility (inherited sterility) over traditional complete sterilization in certain Lepidopteran pest management programs?
(A) F1 sterility strictly kills the initial pest population upon contact.
(B) It ensures the immediate death of the irradiated individual after mating.
(C) It prevents the released insects from flying, confining them to the target field.
(D) Irradiated males retain better mating competitiveness due to lower doses

2025

74. Cytoplasmic incompatibility (CI), used for population suppression, is primarily mediated by which maternally inherited endosymbiotic bacterium?

(C) It copies a homologous template perfectly to duplicate the gene.
(D) It is error-prone and typically introduces insertions or deletions (indels) that disrupt gene function.

2001

90. Arrange the following steps of CRISPR-Cas9 mediated targeted mutagenesis in a pest insect in chronological order.
I. Cas9 undergoes a conformational change and creates a double-strand break.
II. The sgRNA-Cas9 complex scans the genome for a PAM sequence.
III. Endogenous cellular machinery repairs the break via NHEJ, causing an indel.
IV. The sgRNA hybridizes with the complementary target DNA sequence.
(A) II, IV, I, III
(B) II, I, IV, III
(C) IV, II, I, III
(D) I, II, IV, III

2011

91. A Gene Drive system is specifically designed to achieve which outcome in a wild insect population?
(A) To guarantee random Mendelian inheritance of a neutral trait.
(B) To bias inheritance so that specific genetic alterations spread rapidly
(C) To ensure that a beneficial gene is permanently restricted strictly to laboratory strains.
(D) To completely halt all occurrences of genetic mutation within the target species.

2025

92. CRISPR-based homing gene drives operate mechanistically by converting which type of individuals?
(A) Homozygotes into heterozygotes via targeted deletion
(B) Heterozygotes into homozygotes for the drive allele
(C) Somatic cells exclusively into germline cells
(D) Parthenogenetic females into sexual males

2015

93. A population modification (or replacement) gene drive strategy aims primarily to accomplish what end goal?
(A) To replace the existing population with one engineered to be incapable of transmitting a specific disease or causing crop damage
(B) To drive the entire pest population to absolute extinction
(C) To replace a native insect species with a completely different invasive species
(D) To sterilize every female insect in the target ecosystem

2019

94. The rapid evolution of drive-resistant alleles is a major hurdle for CRISPR gene drives. How do these resistant alleles typically originate during the homing process?
(A) The Cas9 enzyme spontaneously denatures inside the nucleus.
(B) Homology-Directed Repair (HDR) flawlessly copies the target sequence.
(C) Error-prone NHEJ repair alters the target sequence so the sgRNA can no longer recognize it.
(D) The insect's immune system produces antibodies against the sgRNA.

2004

95. Consider the following statements concerning 'Daisy-chain' gene drive systems:
I. They are designed to be self-exhausting to prevent uncontrolled global spread.
II. The system components are unlinked and sequentially depend on one another to drive.
III. They guarantee irreversible, permanent modification of the global population.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I

2021

96. Integrating molecular genetic approaches into traditional Integrated Pest Management (IPM) demands rigorous resistance management. Which strategy is most appropriate for delaying pest resistance to a transgenic crop expressing dsRNA?
(A) Planting exclusively the transgenic crop across the entire agricultural landscape continuously
(B) Decreasing the concentration of the expressed dsRNA to sub-lethal levels
(C) Utilizing a refuge strategy where a proportion of non-transgenic crops are planted nearby
(D) Applying broad-spectrum chemical insecticides daily to the transgenic crop

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(dsRNA) into short interfering RNAs (siRNAs).
(C) It serves as a structural component of the insect's ribosome.
(D) It degrades all foreign DNA entering the insect midgut.

2023

82. Which multi-protein complex incorporates the guide strand of the siRNA to seek out and degrade the complementary target mRNA?
(A) The Spliceosome
(B) The Proteasome
(C) The Translocon
(D) The RNA-induced silencing complex (RISC)

2007

83. Systemic RNAi refers to the ability of an organism to spread the silencing signal beyond the initial site of dsRNA uptake. Which order of insects is generally noted for having a highly robust systemic RNAi response, making them excellent targets for this technology?
(A) Coleoptera
(B) Lepidoptera
(C) Diptera
(D) Orthoptera

2023

84. Host-Induced Gene Silencing (HIGS) is an agronomic application of RNAi. What does this technology physically involve?
(A) Spraying synthetic dsRNA directly onto the soil surface to be absorbed by roots
(B) Injecting the insect pest with specific mRNA to over-express lethal proteins
(C) Engineering the crop plant to express dsRNA targeting an essential gene of the insect pest
(D) Using entomopathogenic fungi to deliver small RNAs into the insect hemolymph

2008

85. Match the molecular biology concepts in List I with their corresponding definitions in List II.
List I: (Concept)
P. HIGS
Q. SIGS
R. Dicer
S. Argonaute
List II: (Definition)
1. Endonuclease component of RISC responsible for mRNA cleavage
2. Exogenous topical application of dsRNA for pest control
3. RNase III-like enzyme that processes long dsRNA
4. Transgenic plant expression of dsRNA targeting pest genes
(A) P-4, Q-2, R-3, S-1
(B) P-2, Q-4, R-1, S-3
(C) P-4, Q-2, R-1, S-3
(D) P-3, Q-1, R-4, S-2

2007

86. What represents one of the most significant environmental challenges for the field efficacy of Spray-Induced Gene Silencing (SIGS) formulations?
(A) The dsRNA molecules are hyper-stable and accumulate toxically in soil.
(B) The target insects quickly evolve visual avoidance of the sprayed crop.
(C) Sprayed dsRNA forcibly enters the genome of off-target vertebrate species.
(D) Naked dsRNA is prone to rapid degradation by UV light and nucleases

NODIA

2003

87. In the context of CRISPR-Cas9 genome editing, what is the primary function of the sgRNA (single guide RNA)?
(A) To physically sever the DNA double helix at random intervals
(B) To direct the Cas9 nuclease to the specific complementary genomic target sequence
(C) To repair the broken DNA strands via homologous recombination
(D) To translate the target gene into an inactive protein

2018

88. The Cas9 enzyme requires the presence of a specific short DNA sequence immediately adjacent to the target site to initiate cleavage. What is this sequence called?
(A) TATA box
(B) Shine-Dalgarno sequence
(C) Protospacer Adjacent Motif (PAM)
(D) Poly-A tail

2016

89. After CRISPR-Cas9 induces a double-strand break, the cell may repair it via Non-Homologous End Joining (NHEJ). Why is NHEJ frequently utilized by researchers aiming to knock out a specific insect gene?
(A) It perfectly restores the original DNA sequence, enabling further editing.
(B) It incorporates large segments of viral DNA to create a dominant lethal trait.

discs
(B) To trigger immediate ecdysis
(C) To maintain the status quo, ensuring the next moult results in another larval stage rather than a pupa or adult
(D) To dissolve the existing cuticle rapidly

2023

121. The chemical Methoprene is a synthetic analog of Juvenile Hormone. When it is applied to aquatic environments to control mosquitoes, at what precise developmental transition does it cause mortality?
(A) Egg to first instar larva
(B) Third to fourth instar larva
(C) Adult mating flight
(D) Pupa to adult emergence

2001

122. Which of the following best explains why the widespread agricultural use of azadirachtin (neem extract) rarely results in rapid pest resistance?
(A) It has complex mixtures of biochemicals with diverse modes of action
(B) Azadirachtin is highly mutagenic and lethal to all wild insects.
(C) Pests completely lack gustatory receptors for recognizing botanical compounds.
(D) It is an inorganic compound structurally similar to heavy metals.

2014

123. Chemosterilants like 5-fluorouracil are classified as antimetabolites. What fundamental biological process do they disrupt to prevent successful insect reproduction?
(A) Oxidative phosphorylation in mitochondria
(B) Nucleic acid (DNA/RNA) synthesis and transcription in germ cells
(C) Chitin polymerization in the egg chorion
(D) Action potential propagation in the insect brain

2001

124. The fundamental principle of the Sterile Insect Technique (SIT) requires that the induced sterilization does not critically abolish which specific male behavior?
(A) Feeding on agricultural crops
(B) Dispersing and actively seeking out wild females to mate
(C) Emitting alarm pheromones to warn other males
(D) Producing large quantities of viable, motile sperm

2008

125. In calculating overflooding ratios for an SIT program, if the wild population is estimated at 10^4 males, and the required overflooding ratio for suppression is 10:1 (sterile:wild), how many competitive sterile males must ideally be released?
(A) 10^3
(B) 10^4
(C) 10^5
(D) 10^6

2023

126. Chromosomal translocations engineered for genetic control typically result in partial sterility. What determines the exact level of sterility (e.g., 50%) in an individual heterozygous for a single reciprocal translocation?
(A) The amount of radiation the insect absorbed
(B) The ambient temperature during the pupal development stage
(C) The ratio of adjacent versus alternate chromosome segregation
(D) The insect's dietary intake of essential amino acids

2018

127. Which reproductive manipulation strategy explicitly utilizes the natural phenomenon where sperm from an infected male is lethally incompatible with the egg of an uninfected female?
(A) Sterile Insect Technique via Gamma Radiation
(B) Release of Insects carrying a Dominant Lethal (RIDL)
(C) F1 Inherited Sterility
(D) Cytoplasmic Incompatibility via Wolbachia

2015

128. Systemic RNA interference (RNAi) relies heavily on specific cellular transport mechanisms to spread the silencing signal between cells. Which integral membrane protein is commonly associated with the cellular uptake of dsRNA in many insect species?
(A) Cas9 endonuclease
(B) Ecdysone receptor (EcR)
(C) SID-1 like proteins
(D) Acetylcholinesterase (AChE)

2001

129. Why are Coleoptera generally more susceptible to environmental (ingested) RNAi compared to Lepidoptera?
(A) Coleoptera lack any digestive enzymes in

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2002

97. How does the integration of mass trapping with sex pheromones complement the use of the Sterile Insect Technique (SIT) in an area-wide IPM program?
(A) Mass trapping eliminates all natural enemies, protecting the sterile insects.
(B) Lowering initial wild density makes the required overflooding ratio achievable
(C) Mass trapping strictly captures the released sterile males, providing accurate release data.
(D) Pheromones directly mutate the wild insects, increasing SIT efficacy.

2021

98. From a biosafety perspective, why is the species-specificity of RNA interference (RNAi) considered a major advantage over traditional chemical insecticides?
(A) It permanently eradicates all insect species in the sprayed field.
(B) dsRNA actively fertilizes the crop plant while killing the pest.
(C) RNAi ensures that target insects become highly palatable to predators.
(D) Sequence specificity of dsRNA limits off-target lethality to beneficials

2025

99. The Cartagena Protocol on Biosafety is an international agreement primarily concerned with governing which of the following activities?
(A) The safe handling, transport, and use of living modified organisms (LMOs)
(B) The global trade and application of synthetic chemical fertilizers
(C) The total prohibition of all genetic engineering research in developing nations
(D) The standardization of chemical pheromone dispenser designs

2017

100. Given below are two statements, one labelled as Assertion (A) and the other as Reason (R).
Assertion (A): Ecological risk assessments for genetically modified insects must strictly evaluate the potential for horizontal gene transfer.
Reason (R): Horizontal gene transfer allows the engineered genetic construct to move randomly into entirely unrelated wild species, potentially causing unpredictable ecological consequences.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019

101. Which term specifically describes the unintentional impact of a genetically engineered pest management tool on organisms other than the targeted pest species?
(A) Non-target effect
(B) Synergistic targeting
(C) Intraspecific competition
(D) Autocidal interference

2017

102. When conducting a risk-benefit analysis for the release of a population suppression gene drive, what constitutes a primary ecological risk?
(A) The engineered insects refusing to mate with the wild-type counterparts
(B) An increase in the agricultural yield of the protected crop
(C) The rapid, harmless degradation of the Cas9 protein in the environment
(D) The eradication of a keystone pest species leading to severe disruption of local food webs

2008

103. Which organization or regulatory body is generally responsible for formulating guidelines for the biosafety evaluation of genetically engineered insects in India?
(A) Food Safety and Standards Authority of India (FSSAI)
(B) Genetic Engineering Appraisal Committee (GEAC) under MoEFCC
(C) Indian Space Research Organisation (ISRO)
(D) Bureau of Indian Standards (BIS)

NODIA

2014

104. What is the fundamental goal of a containment strategy when studying novel gene drives in laboratory environments?
(A) To rapidly acclimatize the engineered insects to field conditions
(B) To breed the insects as quickly as possible for commercial sale
(C) To prevent the accidental escape and unintended environmental release of transgenic organisms
(D) To cross-breed the target pest with native beneficial insects

2022

105. Match the risk assessment and regulatory concepts in List I with their appropriate descriptions in List II.

List I: (Regulatory Concept)

P. Off-target mutations
Q. Biosafety containment
R. Reversibility
S. Horizontal gene transfer

List II: (Description)

1. The ability to recall or overwrite a genetic intervention in the wild
2. Physical and biological barriers preventing transgenic escape
3. Movement of genetic material between distinct species
4. Unintended CRISPR cleavage at non-target genomic loci

(A) P-4, Q-2, R-1, S-3
(B) P-1, Q-4, R-2, S-3
(C) P-4, Q-1, R-3, S-2
(D) P-3, Q-2, R-1, S-4

2019

106. In monitoring post-release impacts of GM insects, what role do molecular markers play?

(A) They allow researchers to genetically distinguish between wild-type and mass-released modified individuals in field samples.
(B) They act as physical tags that poison predators.
(C) They visibly change the color of the entire crop canopy for aerial surveys.
(D) They prevent the modified insects from crossing international borders.

2001

107. Public acceptance of genetic pest management technologies is most heavily reliant upon which crucial operational factor?

(A) Complete secrecy regarding the release locations to prevent panic
(B) Transparent risk communication and robust stakeholder engagement
(C) Guaranteeing that the technology is exclusively controlled by private multinational corporations
(D) Ensuring the immediate elimination of all local insect life

2024

108. The ethical debate surrounding the application of population eradication gene drives primarily centers on which ecological premise?

(A) The high financial cost of manufacturing the sgRNA constructs
(B) The right of humans to permanently alter or eliminate entire wild species from the biosphere
(C) The risk of gene drives directly infecting human agricultural workers
(D) The inability of CRISPR-Cas9 to edit DNA accurately in any organism

2011

109. What is a key biological containment strategy implemented in gene drive research to prevent wild-type introgression if an escape occurs?

(A) Engineering the drive into a highly specific synthetic genetic background that is lethal in wild outcrosses
(B) Using target species that thrive globally in all climates
(C) Enhancing the flight capabilities of the laboratory strain
(D) Feeding the laboratory insects exclusively on wild-collected host plants

2023

110. Consider the following statements regarding the integration of chemical ecology and genomics in modern IPM:

I. Genomic data enables the identification of specific olfactory receptors targeted by novel attractants.
II. CRISPR-Cas9 can be used to validate the function of genes involved in pheromone biosynthesis.
III. RNAi cannot be integrated with any pheromone-based trapping systems.
IV. Molecular methods are replacing all need for basic agronomic sanitation practices.

Which of the above statement(s) is/are correct?

(A) I and II
(B) I, II and IV
(C) III and IV
(D) I and III

2015

111. Which of the following is a major physiological mechanism insects use to detect the ratio of components in a species-specific sex pheromone blend?

(A) Broad-spectrum visual analysis of the female's coloration
(B) Gustatory receptors located on the tarsal claws
(C) Direct absorption of the blend through the spiracles into the hemolymph

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(D) Specific Odorant Binding Proteins and Receptors in the antennae

2015

112. Apneumones differ from other allelochemicals strictly based on which specific defining criterion?
(A) They only affect insects in the adult stage.
(B) They are highly repellant to all known predators.
(C) They are emitted by non-living material, such as decaying wood
(D) They consist entirely of inorganic metallic compounds.

2015

113. An insect species utilizes a chemical that attracts individuals of both sexes to a newly discovered food source, facilitating group feeding. What is the most precise classification of this chemical?
(A) Epideictic pheromone
(B) Aggregation pheromone
(C) Sex pheromone
(D) Primer pheromone

2019

114. Why is determining the exact enantiomeric (chiral) structure of a pheromone crucial before synthesizing it for agricultural mass trapping?
(A) Incorrect enantiomers immediately spontaneously combust when exposed to sunlight.
(B) The synthesis of all enantiomers requires the same enzymes, reducing costs.
(C) Insects lack the ability to distinguish between structural stereoisomers.
(D) Only specific enantiomers are active; others may be inactive or repellent

2023

115. Consider the following statements detailing factors that influence the efficacy of pheromone traps:
I. Trap color can synergistically interact with the olfactory cue.
II. The saturation of the sticky liner with dust or captured insects drastically reduces efficiency.
III. Placing traps deep within a dense canopy significantly increases the pheromone plume dispersion area.
IV. The release rate of the dispenser must mimic the natural biological release rate or remain within a specific active threshold.
V. Traps placed directly upwind of the pest source will catch zero insects if the plume does not reach the population.
Which of the above statement(s) is/are correct?
(A) I, II, IV and V
(B) II, III and V
(C) I, III, IV and V
(D) I, II, III and IV

2007

116. Which specific behavioral assay is most commonly used in a laboratory setting to confirm the attractiveness of an extracted sex pheromone to male insects?
(A) High-Performance Liquid Chromatography (HPLC)
(B) Polymerase Chain Reaction (PCR)
(C) Y-tube olfactometer or wind tunnel test
(D) Scanning Electron Microscopy (SEM)

2023

117. In the context of non-pheromone attractants, why is ammonium bicarbonate frequently utilized in traps for certain fruit fly species?
(A) It mimics the volatile profile of decaying food or bird droppings
(B) It functions as a potent visual synergist, reflecting ultraviolet light.
(C) It acts as a contact poison that permanently paralyzes the insect's wings.
(D) It dissolves the trap casing to release sudden bursts of sex pheromone.

2014

118. A compound applied to crop foliage causes a herbivorous insect to take initial test bites but cease prolonged feeding before causing economic damage. This compound is most accurately classified as a:
(A) Contact insecticide
(B) Spatial repellent
(C) Synergistic oviposition lure
(D) Feeding deterrent (antifeedant)

NODIA

2018

119. When classifying insect hormones, which structural category best describes ecdysone?
(A) Neuropeptide
(B) Steroid derivative (Ecdysteroid)
(C) Sesquiterpenoid
(D) Biogenic amine

2011

120. During insect embryogenesis and early larval development, what is the primary role of persistently high titers of Juvenile Hormone (JH)?
(A) To initiate the formation of adult imaginal

2016

137. Which biosafety concern is uniquely associated with "global" homing gene drive systems compared to spatially limited or daisy-chain drives?
(A) They are inherently unable to cross-breed with the target species.
(B) They cost exponentially more to synthesize in the laboratory.
(C) They require hourly manual application to crop foliage by farmers.
(D) The drive allele could cross political borders and spread globally

2024

138. Integration of botanical antifeedants into an IPM program is most advantageous when aimed at achieving which specific outcome?
(A) Preventing feeding damage while preserving natural predator populations
(B) 100% instantaneous mortality of all pest life stages
(C) Eradicating soil-dwelling nematodes and fungi simultaneously
(D) Permanently sterilizing the migrating adult pest population

2013

139. In chemical ecology, how does a highly volatile semiochemical function differently in the field compared to a low-volatility compound?
(A) Volatile compounds function strictly as lethal toxins, while low-volatility compounds are always nutrients.
(B) Volatiles facilitate long-range communication; low-volatiles mediate contact
(C) Volatile compounds only function at extreme sub-zero temperatures.
(D) Volatile compounds are incapable of passing through insect olfactory sensilla.

2023

140. Which specific glandular structure is primarily responsible for the synthesis of juvenile hormone (JH) in the majority of insect species?
(A) Prothoracic gland
(B) Corpora allata
(C) Corpora cardiaca
(D) Subesophageal ganglion

2023

141. Why is the targeted use of Chitin Synthesis Inhibitors (CSIs) highly compatible with classical biological control agents (parasitoids and predators)?
(A) Most adult parasitoids and predators do not actively moult, thus minimizing their susceptibility to CSIs.
(B) CSIs are highly toxic to adult hymenopteran parasitoids.
(C) CSIs rapidly attract parasitoids to the treated fields.
(D) CSIs chemically mimic the host egg, inducing parasitoid oviposition.

2015

142. Mating disruption utilizing synthetic sex pheromones typically requires area-wide application. What happens if this strategy is applied only to a small, isolated 1-hectare field within a massive agricultural landscape?
(A) The pheromone becomes instantly toxic due to high concentration.
(B) The local pest population is perfectly eradicated within one generation.
(C) Mated females from untreated neighbors migrate into the field to lay eggs
(D) The synthetic pheromone forcefully repels all incoming pests.

2009

143. Which technique represents a method of microbe-mediated reproductive manipulation utilized for population suppression in mosquitoes?
(A) Injecting mosquitoes with synthetic juvenile hormone
(B) Coating mosquito resting sites with Bacillus thuringiensis israelensis
(C) Utilizing Agrobacterium to transfer plant genes into the mosquito genome
(D) Releasing male mosquitoes infected with a specific, incompatible Wolbachia strain (Incompatible Insect Technique)

2016

144. In a hypothetical pest management scenario, spraying a field with a dsRNA formulation designed to silence an essential insect gene constitutes which approach?
(A) Host-Induced Gene Silencing (HIGS)
(B) Systemic Acquired Resistance (SAR)
(C) Spray-Induced Gene Silencing (SIGS)
(D) CRISPR-Cas9 genome editing

2019

145. What is the fundamental requirement for the phenomenon of Homology-Directed Repair (HDR) to occur following a CRISPR-Cas9 double-strand break?
(A) A severe drop in cellular ATP levels
(B) The presence of a donor DNA template

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their midgut.
(B) Lepidoptera express active midgut dsRNases that degrade ingested RNA
(C) Coleoptera do not possess a genome capable of transcription.
(D) Lepidoptera exclusively utilize microRNAs rather than siRNAs.

2018

130. In designing sgRNA for CRISPR-Cas9 genome editing in an agricultural pest, minimizing off-target effects is critical. How is this typically achieved computationally before physical experiments begin?
(A) By selecting a target sequence that is universally conserved across all domains of life
(B) Using bioinformatic alignments to ensure the sequence is unique
(C) By randomly generating RNA sequences without any genomic reference
(D) By strictly targeting regions composed entirely of repetitive structural heterochromatin

2002

131. A population suppression gene drive specifically targeting a highly conserved, essential female fertility gene (e.g., doublesex) is designed to spread rapidly. What happens when the drive allele reaches fixation (100% frequency) in the wild population?
(A) Collapse of the population occurs due to the lack of fertile females
(B) The population becomes highly resistant to all chemical pesticides.
(C) All individuals become fertile, asymptomatic carriers of the drive.
(D) The population immediately undergoes speciation into a new distinct lineage.

2022

132. When conducting a laboratory evaluation of a novel insect repellent, which standard metric characterizes the repellent's efficacy over time?
(A) LC50 (Lethal Concentration 50)
(B) Overflooding ratio
(C) Complete Protection Time (CPT)
(D) Economic Injury Level (EIL)

2022

133. The "Push-Pull" agricultural strategy brilliantly integrates two distinct behavioral modifiers. In the classic maize stemborer Push-Pull system, what roles do the intercrop (Desmodium) and the trap crop (Napier grass) play, respectively?
(A) Desmodium acts as a repellent (push), while Napier grass acts as an attractant (pull).
(B) Desmodium acts as an attractant (pull), while Napier grass acts as a repellent (push).
(C) Both plants act as powerful synthetic attracticides.
(D) Both plants strictly provide a physical barrier to insect flight.

2008

134. Which phenomenon poses the greatest biological threat to the long-term sustainability of the Sterile Insect Technique (SIT)?
(A) Evolution of complete biochemical resistance to pheromone lures
(B) Sterile insects mutating into fertile forms upon contact with sunlight
(C) Rapid increase in plant defenses due to the presence of sterile insects
(D) Laboratory adaptation of the strain leading to loss of field competitiveness

2017

135. What defines a "conditional lethal mutation" in the context of the RIDL genetic control system?
(A) A mutation that causes death only when the insect encounters a specific species of predator
(B) A fatal mutation in the wild that is suppressed by a laboratory additive
(C) A mutation that only kills the insect if it successfully mates with a closely related species
(D) A mutation that unconditionally kills the insect in the egg stage, preventing any rearing

2005

136. When CRISPR-Cas9 is utilized to create a knock-out mutation via Non-Homologous End Joining (NHEJ), what exact molecular flaw leads to the loss of gene function?
(A) The complete replacement of the insect chromosome with viral RNA
(B) The hyper-methylation of the promoter region
(C) Frameshift mutations caused by indels, leading to premature stop codons
(D) The exact duplication of the target gene, causing lethal over-expression

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(A) Wolbachia pipientis
(B) Bacillus thuringiensis
(C) Agrobacterium tumefaciens
(D) Pseudomonas syringae

2003

75. Consider the following statements regarding Wolbachia-induced Cytoplasmic Incompatibility (CI):

I. CI causes embryo death when a Wolbachia-infected male mates with an uninfected female.
II. CI allows an uninfected male to successfully reproduce with an infected female.
III. Wolbachia is horizontally transmitted through the air between adult insects.
IV. CI can be harnessed to drive desirable genes through an insect population.
V. CI-based sterile insect techniques require releasing only infected females to crash the population.

Which of the above statement(s) is/are INCORRECT?
(A) I, II and IV
(B) III and V
(C) I, III, IV and V
(D) II, III and V

2021

76. In an Incompatible Insect Technique (IIT) program utilizing Wolbachia, why is the accidental release of Wolbachia-infected females considered highly detrimental to the suppression goal?
(A) The infected females will predate on the infected males.
(B) Infected-infected mating yields viable offspring, spreading the strain
(C) Infected females transmit human diseases more efficiently than uninfected ones.
(D) The Wolbachia strain will instantly mutate into a lethal pathogen for the local crops.

2003

77. To determine the necessary number of sterile insects to release, an overflooding ratio must be established. What does the term "overflooding ratio" refer to?
(A) The number of released steriles relative to the estimated wild population
(B) The ratio of crop plants to the number of wild pest insects
(C) The ratio of irrigation water volume to total field area
(D) The proportion of sterile males that successfully locate a food source

2012

78. If wild males possess a mating competitiveness value of 1.0, and mass-reared sterile males have a value of 0.5, what operational adjustment must be made to achieve theoretical suppression?
(A) The release number of sterile males must be halved.
(B) The sterile males must be released strictly at night.
(C) The number of sterile males released must be increased to compensate
(D) The release program must be immediately abandoned as suppression is biologically impossible.

2005

79. Why is Area-Wide Integrated Pest Management (AW-IPM) critically essential for the success of SIT programs?
(A) SIT only functions when applied universally across all known insect taxa simultaneously.
(B) Sterile insects are physically larger and require vast agricultural spaces to fly.
(C) It is a strict legal requirement enforced by the World Health Organization for all biological controls.
(D) Unmanaged neighbor areas act as constant sources of fertile pest reinvasion

2023

80. Given below are two statements, one labelled as Assertion (A) and the other as Reason (R).
Assertion (A): SIT programs often implement a preliminary population reduction phase using chemical insecticides before releasing sterile males.
Reason (R): Releasing sterile insects into an extremely dense wild population requires impractically high numbers of sterile males to achieve an effective overflooding ratio.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

NODIA

2006

81. In the mechanism of RNA interference (RNAi), what is the specific role of the Dicer enzyme?
(A) It transcribes single-stranded mRNA from the host's DNA.
(B) It cleaves long double-stranded RNA

possessing sequence homology flanking the break site
(C) The complete absence of the Dicer enzyme
(D) The immediate degradation of the Cas9 protein

2007

146. A critical step in assessing the ecological risk of transgenic insect release is evaluating "fitness costs." What does this term imply regarding the modified insect?
(A) The financial expenditure required to rear the insect
(B) The increased physical size and aggressive behavior of the engineered strain
(C) The insect's enhanced ability to rapidly metabolize chemical insecticides
(D) The reduction in survival, reproductive capacity, or mating competitiveness compared to wild-type individuals

2008

147. Pheromone dispenser types such as microencapsulation are explicitly designed to alter which physical parameter of the chemical application?
(A) Controlled, slow release of the active ingredient over an extended period
(B) The molecular weight of the active compound
(C) The exact stereochemistry of the pheromone
(D) The visual color spectrum of the final agricultural spray

2014

148. Which factor is most likely to decrease the efficiency of a pheromone-baited trap designed to monitor a low-density invasive pest population?
(A) Using a dispenser with an optimized, highly stable release rate
(B) Placing the trap in a location with competing high-concentration artificial light sources, if visual cues are ignored
(C) Using a highly impure synthetic blend that contains antagonistic impurities
(D) Deploying the traps precisely at the canopy level where the pests actively fly

2011

149. Why is the precise timing of application crucial when using juvenile hormone (JH) mimics for pest management?
(A) Application must occur when endogenous JH titers naturally drop to zero
(B) JH mimics are only stable in sunlight for a few minutes.
(C) They exclusively target the pupal stage, which only lasts 24 hours.
(D) They require high humidity to actively penetrate the adult exoskeleton.

2001

150. A major ecological advantage of employing Autocidal control strategies (like SIT) compared to broad-spectrum chemical insecticides is:
(A) SIT provides instant, broad-spectrum mortality of all feeding larvae
(B) SIT remains consistently effective against multiple unrelated pest taxa
(C) SIT requires no specialized rearing infrastructure or financial investment
(D) SIT is species-specific and poses minimal risk to non-target organisms

2014

151. If a gene drive system designed for population replacement successfully introgresses an anti-pathogen effector gene into a mosquito population, what is the ultimate public health objective?
(A) To increase the overall lifespan of the wild mosquito population
(B) To render the wild population genetically incapable of transmitting disease
(C) To cause the immediate collapse and extinction of all mosquito species
(D) To train the mosquitoes to strictly feed on non-human hosts

2002

152. In an Area-Wide Integrated Pest Management (AW-IPM) framework integrating RNAi, how might a traditional chemical insecticide be strategically utilized?
(A) Mixed directly into the dsRNA formulation to chemically bond with the nucleotides
(B) Applied as a knockdown tool to reduce outbreaks before deploying RNAi
(C) Formulated as a soil drench to enhance root uptake of the silencing signal
(D) Injected directly into the transgenic crop stems daily

2008

153. A chemical ecologist discovers a new semiochemical emitted by a predator that strongly deters oviposition by a specific pest species. For the pest species, this chemical acts as a:
(A) Pheromone
(B) Synomone

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27. (B) Physical repellents act via tactile irritation while chemical ones target receptors
The distinction between physical and chemical repellents lies in their mode of action. Physical repellents, such as certain oils or dusts, often cause tactile irritation or create a mechanical barrier that makes the surface uncomfortable for the insect. Chemical repellents, however, interact specifically with the insect's olfactory or gustatory receptors to trigger an avoidance response without requiring physical contact or irritation.

28. (B) N,N-Diethyl-meta-toluamide (DEET)
N,N-Diethyl-meta-toluamide, commonly known as DEET, has been the primary active ingredient in insect repellents for decades. It provides long-lasting protection against a broad spectrum of biting arthropods, including mosquitoes, ticks, and fleas. DEET works by interfering with the insect's olfactory receptors, effectively masking the chemical cues like carbon dioxide and lactic acid that insects use to locate human hosts.

29. (A) Picaridin is less likely to degrade synthetic fabrics and plastics upon contact.
Picaridin is a synthetic repellent modeled after the plant-derived compound piperine. A significant advantage of picaridin over DEET in consumer use is its compatibility with materials. While DEET acts as a solvent that can damage or melt synthetic fabrics, plastics, and watch crystals, picaridin is non-greasy and generally safe for these materials. It also offers comparable efficacy with less odor.

30. (C) I, III and V
Botanical repellents like citronella are highly volatile, which generally results in a shorter duration of protection compared to synthetic alternatives. Consequently, these natural products often require more frequent reapplication to remain effective. Many essential oils work by disrupting the normal functioning of insect olfactory receptor neurons, though they can still cause skin irritation or allergic reactions in some users.

31. (D) Olfactory receptor neurons
Citronellal, a major constituent of citronella oil, exerts its repellent effect by targeting the olfactory system of mosquitoes. It interacts with specific olfactory receptor neurons on the antennae, disrupting the insect's ability to detect or orient toward host-derived attractants. This interference prevents the mosquito from accurately locating a blood meal, thereby providing a level of protection for the treated individual.

NODIA

32. (C) Gustatory sensilla on the mouthparts and tarsi
Insect antifeedants, or feeding deterrents, act primarily through the gustatory system. When an insect contacts or tastes a treated surface, these compounds interact with specialized gustatory sensilla located on the mouthparts, tarsi, or antennae. This sensory interaction sends a signal to the insect's nervous system to cease feeding, regardless of hunger, effectively protecting the plant tissue from significant consumption.

33. (B) It disrupts the endocrine system, specifically altering ecdysone levels and moulting.
Azadirachtin is renowned as a potent antifeedant, but it also functions as a powerful insect growth regulator. It disrupts the endocrine system by interfering with the synthesis and release of ecdysteroids and juvenile hormone. This leads to severe abnormalities in the moulting process, preventing successful metamorphosis and resulting in the death of immature insects during the larval or pupal stages.

34. (D) Colorado potato beetle (Leptinotarsa decemlineata)
Limonin is a citrus-derived limonoid that exhibits significant antifeedant activity against several insect pests. It is particularly noted for its effectiveness in reducing the feeding damage caused by the Colorado potato beetle. By deterring both the larvae and adults of this pest from consuming potato foliage, limonin serves as an important naturally derived tool in integrated pest management strategies.

35. (A) Both A and R are true and R is the correct explanation of A.
The long-term field efficacy of synthetic antifeedants is often limited by a phenomenon known as habituation. This occurs when an insect's nervous system becomes less responsive to a deterrent stimulus after repeated or continuous exposure. As the insect neurologically adapts to the sensory signal, it may eventually resume feeding on the treated crop, rendering the behavioral control strategy ineffective.

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ANSWERS

1. (B) Chemicals secreted to the external environment that mediate interactions between organisms
Semiochemicals are signal-bearing chemical substances released by organisms into the external environment to communicate or elicit specific behavioral or physiological responses in other individuals. These molecules facilitate interactions either between members of the same species, known as pheromones, or between individuals of different species, referred to as allelochemicals, playing a critical role in ecological dynamics and communication.

2. (D) Kairomone
Kairomones are interspecific semiochemicals that provide an adaptive advantage to the receiver while being detrimental to the emitter. These substances often include host-produced volatiles or metabolic by-products that predators, parasitoids, or herbivores utilize to locate food sources or suitable hosts. In evolutionary ecology, these signals represent a cost to the organism producing them due to increased predation or herbivory.

3. (A) Synomones benefit the emitting organism but negatively affect the receiving organism.
Synomones are specialized allelochemicals that mediate interspecific interactions to provide a mutual benefit for both the emitting and receiving organisms. Common examples include floral scents that attract pollinators to flowers for nectar, facilitating plant reproduction. This classification is distinct from allomones, which benefit only the emitter, and kairomones, which benefit only the receiver at the expense of the emitting source.

4. (C) A plant emitting volatile compounds when attacked by an herbivore, attracting parasitoids
A classic illustration of synomones involves plants releasing herbivore-induced plant volatiles upon being attacked. These chemical signals attract natural enemies, such as predators or parasitoids, which then consume or parasitize the feeding herbivores. This interaction is mutually beneficial because the plant receives protection from further herbivory, while the natural enemies successfully locate a necessary food source or larval host.

5. (C) I and III
Allomones represent a category of allelochemicals that facilitate communication between different species. These substances provide a clear adaptive advantage to the emitting organism by influencing the behavior or physiology of the receiver in a way that is neutral or harmful to the receiver. Common defensive secretions, such as those produced by stink bugs, exemplify how allomones protect the emitter.

6. (D) The compound serves primary metabolic functions essential for the plant's survival.
Plants often emit volatile compounds that inadvertently act as kairomones for herbivores because these substances are intrinsically linked to primary metabolic pathways. Since these molecules are essential for the plant's internal physiological processes or survival, natural selection cannot easily suppress their emission despite the negative consequence of attracting pests. The metabolic cost of eliminating these vital pathways would outweigh damage.

7. (B) Assessment of resource exploitation to ensure adequate spacing
Epideictic pheromones, also known as marking or spacing pheromones, are utilized by insects to signal that a specific resource is already occupied or exploited. For instance, female fruit flies may deposit these chemicals on a fruit after oviposition. This chemical signal informs other conspecifics to avoid the resource, thereby reducing intraspecific competition and ensuring sufficient nutrients for the larvae.

8. (C) Aggregation pheromones attract both sexes, whereas sex pheromones typically attract one specific sex.
Aggregation pheromones are semiochemicals that induce individuals of both sexes to cluster together, often for purposes like mass host colonization or defense. In contrast, sex pheromones are usually produced by one sex, predominantly females, to attract members of the opposite sex for mating. Understanding

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this distinction is vital for developing effective monitoring and mass-trapping strategies in pest management systems.

9. (D) Dufour's gland or sternal glands
In social insects like ants and termites, trail pheromones are synthesized and secreted by specialized exocrine glands such as the Dufour's gland, sternal glands, or Pavan's gland. These chemicals are deposited onto the substrate as foragers return to the nest, creating a path that guides other workers toward reliable food sources or new nesting sites, facilitating efficient colony recruitment.

10. (C) A is true but R is false.
Aphids release alarm pheromones, such as (E)-beta-farnesene, when threatened by predators, triggering immediate defensive responses like dropping from the host plant. However, these molecules are typically small and highly volatile to ensure rapid dispersal through the air for quick communication. This high volatility means they do not persist in the environment for long periods, unlike heavier, more stable semiochemicals.

11. (B) Aphididae (Aphids)
Members of the family Aphididae are well-known for producing (E)-beta-farnesene from their cornicles when under attack. This sesquiterpene serves as a universal alarm pheromone for many aphid species, signaling nearby conspecifics to stop feeding and move away or drop from the plant. This rapid chemical signaling system is a key survival mechanism against predators like ladybirds and lacewing larvae.

12. (B) A significant reduction in the frequency of successful copulations
Successful mating disruption is achieved by saturating the agricultural environment with synthetic sex pheromones, which prevents male insects from locating and mating with females. This leads to a substantial decline in the number of successful copulations within the pest population. Consequently, the female insects fail to lay fertile eggs, resulting in a significantly reduced larval population and less damage.

13. (A) Combining a semiochemical attractant with a toxicant to eliminate the responding insects
The lure-and-kill or attracticide strategy utilizes a chemical attractant, such as a pheromone or food lure, to draw target pests toward a specific site. This site is treated with a lethal agent, typically a fast-acting insecticide. By concentrating the toxicant at the lure source, the technique effectively eliminates the attracted insects while minimizing the total amount of insecticide applied.

14. (C) At low initial pest population densities in relatively isolated or enclosed ecosystems
Mass trapping is most effective as a population suppression tool when the target pest population is at a low density and confined to an isolated or enclosed area. Under these conditions, a high proportion of the insects can be removed from the environment before they reproduce. In contrast, high-density populations or open fields often experience rapid immigration, neutralizing the impact.

NODIA

15. (A) P-2, Q-4, R-1, S-3
Behavioral control strategies utilize various mechanisms to manage pest populations. Mass trapping involves removing individuals using physical traps baited with lures. Mating disruption relies on permeating the air with pheromones to prevent mate location. Attracticides combine lures with insecticides for direct mortality. The push-pull strategy employs both repellents to drive pests away and attractants to lure them into traps.

16. (C) Capillary tubes cannot be deployed using standard liquid agricultural spraying equipment.
Capillary tube dispensers are discrete units that must be manually placed or hung within the field environment to release pheromones. Unlike microencapsulated formulations, which are designed as liquid suspensions, capillary tubes cannot be applied using standard agricultural spraying machinery. This limitation increases the labor requirements for installation and makes large-scale application across vast areas more difficult and less efficient.

17. (B) The nutritional status of the host plant beneath the trap
The efficiency of a pheromone-baited trap is determined by various physical and chemical parameters, including trap design, height, and the release rate of the dispenser. Environmental factors such as wind speed and temperature also significantly affect the formation of the pheromone plume. While host plant volatiles

can interact with pheromones, the internal nutritional status of a specific plant is unlikely.

18. (D) PVC matrices - Binds pheromones covalently to prevent all environmental degradation.
Polyvinyl chloride (PVC) matrices are used in pheromone dispensers to hold the active ingredient within a polymer structure, allowing for gradual release via diffusion. They do not typically form covalent bonds with the pheromone molecules, as such bonding would prevent the necessary evaporation and release into the atmosphere. Most dispensers rely on physical entrapment and controlled diffusion through polymers.

19. (A) It shields the sticky surface from dust and water
The delta trap is characterized by its triangular cross-section, which creates an internal housing for the sticky liner and pheromone lure. This specific design protects the adhesive surface from environmental factors such as heavy rain and dust accumulation. By maintaining the integrity of the sticky surface, the trap remains effective for a longer duration, ensuring accurate monitoring of lepidopteran pests.

20. (D) IV
Mating disruption works through several sub-lethal mechanisms, including false trail following, sensory fatigue, and plume camouflage, which prevent males from finding females. It is important to note that this strategy does not typically result in the direct death of the female insects. Instead, it prevents population growth by inhibiting the reproductive process, thereby reducing the number of fertilized eggs.

21. (A) Food and feeding lures
Food and feeding lures often consist of volatile organic compounds that simulate the odors of ripening fruit, floral nectar, or decaying organic matter. Many insects are attracted to products of microbial fermentation, such as alcohols, esters, and acids, which indicate the presence of a suitable nutrient source. These lures are widely used to monitor and trap various flies and beetles.

22. (D) Male-specific parapheromone attractant
Methyl eugenol is a naturally occurring compound that acts as a powerful parapheromone attractant for the males of certain Tephritid fruit fly species. Upon ingestion, it is often converted into components of the male's sex pheromone. In pest management, it is used extensively in male annihilation programs to trap and kill males, thereby preventing the fertilization of wild female insects.

23. (B) Insects use olfactory cues for navigation and visual cues for targeting
Insects often utilize a multi-modal sensory approach for locating resources. Olfactory cues, such as pheromones or host volatiles, are typically used for long-distance navigation and orientation into the wind. Once the insect is in close proximity to the source, visual cues like color or shape become essential for final targeting and landing. Combining these cues in traps maximizes efficiency.

24. (C) Food attractant
Baits containing hydrolysed protein act as potent food attractants for various insects, particularly tephritid fruit flies. These insects require protein sources for sexual maturation and egg production. The volatile ammonia and other nitrogenous compounds released by the protein mimic natural food sources like bird droppings or bacteria, inducing a feeding-related search behavior that leads the insects into the trap.

25. (A) Activation → Upwind oriented flight → Visual orientation → Landing/Capture
When navigating toward an attractant source, an insect first undergoes physiological activation upon detecting the chemical signal. This is followed by anemotaxis, or upwind oriented flight, to stay within the odor plume. As the insect nears the source, it transitions to visual orientation to pinpoint the exact location. Finally, the behavioral sequence culminates in landing on the substrate and capture.

26. (A) Sinigrin (a glucosinolate) for the cabbage white butterfly
Sinigrin is a glucosinolate compound found in cruciferous plants that acts as a specific chemical cue for specialist insects. For the cabbage white butterfly, sinigrin serves as a potent oviposition stimulant, guiding the female to a suitable host plant for its offspring. While many botanical compounds function as deterrents or toxins, sinigrin illustrates how specialists utilize plant chemistry for host recognition.

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the germ cells of treated insects. Because they mimic the sterilizing effects of gamma or X-rays through chemical means, they are specifically referred to as radiomimetic substances.

63. (D) Manipulating the pest population so that its members contribute to the reduction or extinction of their own species
Autocidal control is a pest management strategy that uses the target insect itself to suppress its own population. This is achieved by introducing sterile or genetically modified individuals into the wild population. When these released insects mate with wild counterparts, they produce no offspring or offspring with lethal traits. Over time, this process leads to a significant decline in the population size.

64. (C) Late pupae or newly emerged adults
In Sterile Insect Technique programs, the timing of sterilization is critical to balance sterility with biological fitness. Insects are typically subjected to ionizing radiation during the late pupal stage or shortly after they emerge as adults. At this point, the reproductive tissues are developing or mature, making them highly sensitive to radiation-induced damage, while the somatic tissues are already sufficiently robust.

65. (B) II and III
The success of the Sterile Insect Technique depends on several factors. Released sterile males must remain healthy and competitive enough to successfully mate with wild females in the field. Additionally, it is essential that the released insects themselves, particularly if females are included, do not cause significant economic damage to the crops or livestock they are meant to protect from pests.

66. (D) Creation of dominant lethal mutations via chromosomal strand breaks
Gamma radiation induces sterility by causing extensive physical damage to the DNA within an insect's gametes. The ionizing energy leads to chromosomal strand breaks and structural rearrangements. These changes result in dominant lethal mutations; while the sperm remains motile and can fertilize an egg, the resulting zygote fails to develop properly and dies, thereby preventing the production of viable offspring.

67. (A) Screwworm fly (Cochliomyia hominivorax)
The landmark achievement in the history of the Sterile Insect Technique was the successful eradication of the screwworm fly from North and Central America. This devastating livestock pest caused immense economic losses by infesting the open wounds of animals. By mass-rearing, sterilizing, and releasing millions of male flies, researchers were able to crash the wild population and eliminate the pest.

68. (C) Females typically mate only once during their lifetime.
The eradication of the screwworm fly was highly feasible because female flies are typically monogamous, mating only once in their lifetime. If a wild female mates with a released sterile male, all of her eggs will be infertile, and she will not seek another mate. This behavioral trait significantly accelerates the population decline compared to species where females mate multiple times.

69. (A) It allows for the exclusive mass-release of sterile males, preventing damage by sterile females.
Genetic Sexing Strains are engineered to allow the easy separation of males and females during the mass-rearing process, often using temperature-sensitive or color-based markers. The primary advantage of releasing only sterile males is that it prevents the economic damage that sterile females might still cause, such as fruit puncturing during attempted oviposition, while also increasing the overall efficiency.

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70. (A) I, II, III, IV
An operational Sterile Insect Technique program follows a logical sequence of phases. First, large numbers of the target pest are produced in mass-rearing facilities. These insects are then sterilized using ionizing radiation. Following sterilization, the sterile insects are released into the target area. Finally, the program includes continuous population monitoring to evaluate the effectiveness of the releases and guide future actions.

71. (B) By causing unequal chromosome segregation leading to inviable zygotes
Reciprocal translocations involve the exchange of segments between non-homologous chromosomes. In individuals heterozygous for such translocations, meiosis often results in

36. (C) An antifeedant prevents food ingestion; attracticides lure then kill the pest
The fundamental difference between these two strategies lies in their primary mode of operation. Antifeedants are behavioral modifiers that inhibit the insect's desire to feed on a substrate, thereby preventing crop damage through starvation or avoidance. In contrast, attracticides use a lure to actively draw the pest toward a site where it is killed by a concentrated toxic agent.

37. (A) Located behind the brain; synthesizes and secretes juvenile hormone (JH)
The corpora allata are a pair of small endocrine glands located behind the insect brain. Their primary physiological role is the synthesis and secretion of juvenile hormone. This hormone is essential for regulating various developmental processes, particularly maintaining the insect in its immature larval or nymphal state during moulting and, in many adults, influencing reproductive functions such as egg production.

38. (D) Prothoracicotropic hormone (PTTH)
In the insect endocrine cascade, the prothoracic glands are stimulated by the neuropeptide prothoracicotropic hormone, which is produced by neurosecretory cells in the brain and released into the hemolymph. Once activated by PTTH, the prothoracic glands synthesize and secrete ecdysone, the prohormone that initiates the cellular processes of apolysis and the formation of a new cuticle during the moulting cycle.

39. (B) High titer of ecdysone in the complete absence of juvenile hormone
Metamorphosis in holometabolous insects is strictly controlled by the relative concentrations of hormones. For the transition from the final larval instar to the pupal stage, a peak in ecdysone is required while the titer of juvenile hormone drops to near zero. This absence of JH allows the insect to transition into the next developmental phase rather than undergoing another larval-larval moult.

40. (A) P-3, Q-4, R-1, S-2
The insect endocrine system involves several key components. Neurosecretory cells in the pars intercerebralis synthesize PTTH, which is stored and released by the corpora cardiaca. The corpora allata are responsible for producing juvenile hormone. The prothoracic glands synthesize ecdysone, the precursor to the active moulting hormone. Coordination between these tissues ensures the precise timing of moulting and metamorphosis throughout development.

41. (D) Fat body and epidermal cells
Ecdysone, secreted by the prothoracic glands, acts as a prohormone and must be converted into the more active 20-hydroxyecdysone to exert its biological effects. This hydroxylation process occurs primarily in peripheral tissues such as the fat body and epidermal cells. Once activated, 20-hydroxyecdysone binds to its nuclear receptors to trigger the gene expression necessary for the moulting process to proceed.

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42. (A) Morphogenetic disruption
Application of juvenile hormone analogs to late-instar larvae causes significant morphogenetic disruption by interfering with the signal to pupate. The presence of exogenous JH mimics prevents the insect from transitioning to the pupal stage, instead forcing it to undergo an additional, supernumerary larval moult. These giant larvae are typically unable to survive or successfully complete metamorphosis into reproductive adults later.

43. (B) Juvenile hormone (JH) analog
Methoprene is a synthetic chemical compound that functions as a juvenile hormone analog. It mimics the natural hormone's role in maintaining the insect in an immature state. In pest control, particularly for mosquitoes and fleas, it is used to disrupt normal development, preventing the emergence of viable adults from the larval or pupal stages without directly killing the larvae.

44. (B) It mimics juvenile hormone, keeping the pest in an immature, non-reproductive stage.
Fenoxycarb is a carbamate-based insect growth regulator that acts as a juvenile hormone mimic. Its primary mode of action involves disrupting the endocrine balance required for successful metamorphosis. By mimicking JH, it prevents the final moult into the adult stage, often causing the insect to remain in a non-reproductive state or undergo a lethal, abnormal moult that leads to death.

45. (A) II, I, IV, III
The moulting process begins when brain neurosecretory cells are activated to produce prothoracicotropic hormone. This PTTH is then released into the hemolymph from the corpora

(C) Kairomone
(D) Allomone

2008

154. What constitutes a profound ethical challenge associated with the potential release of an eradication-focused CRISPR gene drive?
(A) Permanent species eradication alters ecosystems without global consent
(B) Gene drives require the unethical use of highly radioactive materials in open fields.
(C) The technology relies on capturing and torturing vertebrate animals.
(D) Eradication guarantees that the targeted insect will immediately evolve into a mammalian parasite.

2022

155. The concept of "reversibility" in genetic pest management aims to address environmental biosafety concerns. How might a reversible gene drive theoretically function?
(A) By spraying the environment with a chemical that physically disintegrates DNA
(B) Using a "recall" drive to overwrite the drive with wild-type genetics
(C) By simply halting the mass rearing facility, causing the drive to vanish instantly
(D) By training the modified insects to spontaneously migrate into the ocean

2008

156. In classical SIT history, why was the melon fly (Bactrocera cucurbitae) eradication program in Okinawa considered a tremendous, complicated success?
(A) It required almost no sterile insects due to the tiny size of the island.
(B) It managed polyphagous pests over a complex archipelagic environment
(C) The eradication was achieved exclusively using a single application of chemosterilant baits.
(D) The melon fly went spontaneously extinct before the program began.

2015

157. The use of chemosterilants in field baits theoretically offers an advantage over traditional SIT. What is this advantage?
(A) It removes costs associated with mass-rearing and artificial irradiation
(B) Chemosterilants perfectly mimic all known sex pheromones simultaneously.
(C) Chemosterilants are completely non-toxic to human beings.
(D) Field sterilization guarantees that the insects instantly lose their flight capability.

2007

158. Which of the following accurately describes the primary enzymatic activity of the Argonaute protein within the RISC complex during RNA interference?
(A) It synthesizes secondary dsRNA strands from a DNA template in the nucleus
(B) It seals cleaved mRNA fragments together to prevent systemic cellular damage
(C) It acts as an endonuclease, cleaving mRNA complementary to the guide RNA
(D) It facilitates the active pumping of dsRNA out of the cell to prevent silencing

2001

159. When comparing Host-Induced Gene Silencing (HIGS) to traditional Bt transgenic crops, what is a unique mechanistic characteristic of HIGS?
(A) HIGS expresses a crystalline protein toxin that binds to midgut receptors.
(B) HIGS mechanically reinforces the plant cell wall using immense amounts of lignin.
(C) HIGS requires the insect to physically inject saliva into the phloem to trigger an explosion.
(D) HIGS targets the degradation of the insect's own specific mRNA transcripts

2006

160. What is a critical element in establishing the biosafety framework for the deliberate environmental release of genetically modified insects?
(A) Ensuring that the released organisms are completely invisible to the naked eye
(B) Bypassing all local government regulations to ensure rapid deployment
(C) Implementing a tiered assessment of impacts on non-targets and food webs
(D) Guaranteeing that the modified insects will eventually crossbreed with economically valuable honeybees

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cuticle for growth, such as larvae and nymphs during their frequent moults. They can also affect developing embryos within eggs. However, adult insects have already completed their final moult and possess a fully formed, hardened exoskeleton. Therefore, they are generally the least susceptible to the direct lethal effects of CSIs.

55. (A) Both A and R are true and R is the correct explanation of A.
Chitin synthesis inhibitors are primarily formulated as stomach poisons because they are most effective when ingested by the target pest. Once inside the insect, the active compounds are absorbed into the hemolymph and transported to the epidermal cells. In these cells, they interfere with the synthesis of the new cuticle, leading to death during the next moult. Contact activity is generally limited.

56. (C) They cross-link DNA strands to inhibit replication and cause mutations
Alkylating agents are potent chemosterilants that function by adding alkyl groups to DNA molecules within germ cells. This biochemical reaction often results in the cross-linking of DNA strands, which physically blocks the replication process and induces significant chromosomal damage. Such disruptions lead to dominant lethal mutations in gametes, ensuring that any zygotes formed after mating are inviable, thereby achieving sterility.

57. (D) Alkylating agents
TEPA and METEPA are classic examples of alkylating chemosterilants used in early entomological research. These compounds are highly reactive and interfere directly with the genetic material of the insect. By causing extensive damage to DNA through alkylation, they induce sterility in both males and females. Due to their high toxicity and mutagenic potential, their use is now strictly controlled and limited in applications.

58. (A) By mimicking natural nucleosides, thereby interfering with normal nucleic acid synthesis
Antimetabolite chemosterilants, such as 5-fluorouracil, are structural analogs of essential cellular metabolites like nucleosides. During the production of gametes, these compounds are mistakenly incorporated into developing DNA or RNA strands or inhibit the enzymes responsible for their synthesis. This interference disrupts normal nucleic acid metabolism, leading to the production of non-functional germ cells and resulting in the sterility of the treated insect.

59. (B) They exhibit high mutagenicity, carcinogenicity, and toxicity to mammals and humans.
Although alkylating agents are effective chemosterilants, their widespread agricultural use is severely restricted by significant biosafety concerns. These compounds are non-selective and can cause similar DNA damage in non-target organisms, including humans. Their high potential for mutagenicity, carcinogenicity, and general mammalian toxicity makes them environmentally hazardous, requiring the development of safer, more specific genetic or behavioral pest control alternatives.

60. (A) P-3, Q-1, R-4, S-2
Different chemical classes target various aspects of insect development and reproduction. Methoxyfenozide is a well-known ecdysone agonist that induces lethal premature moults. Diflubenzuron acts as a chitin synthesis inhibitor, disrupting cuticle formation. Methoprene mimics juvenile hormone to prevent adult emergence. TEPA is an alkylating chemosterilant that causes sterility through DNA damage. Together, these tools provide diverse options for modern management.

61. (A) Baits selectively target the pest while minimizing environmental contamination and exposure to non-targets.
Utilizing bait stations for the delivery of chemosterilants is a strategic choice to enhance safety and efficiency. Baits can be formulated with specific attractants that selectively draw the target pest to the chemical, thereby reducing the total amount of hazardous material released into the environment. This localized application minimizes the exposure of beneficial insects and humans compared to broad-spectrum foliar sprays.

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62. (C) Radiomimetic compounds
Radiomimetic compounds are a category of chemosterilants, primarily including alkylating agents, that produce biological effects very similar to those caused by ionizing radiation. These chemicals induce extensive chromosomal breakages and dominant lethal mutations in

cardiaca. PTTH travels to the prothoracic gland, stimulating the secretion of ecdysone. Finally, increasing titers of the active hormone cause epidermal cells to undergo apolysis and begin the synthesis of a new cuticle beneath the old.

46. (C) It prevents adult emergence from pupae by disrupting metamorphosis.
Pyriproxyfen is a potent juvenile hormone analog used extensively to control mosquito populations. It works by interfering with the hormonal regulation of metamorphosis, specifically preventing the transition from the pupal stage to the adult stage. Mosquitoes exposed to pyriproxyfen as larvae often fail to emerge as adults from their pupal cases, thereby effectively breaking the pest's life cycle.

47. (D) Vertebrates lack the specific intracellular receptors necessary for JH binding.
Juvenile hormone analogs exhibit high selectivity and safety because the specific intracellular receptors to which they bind are unique to insects and some other arthropods. Vertebrates, including humans and other mammals, do not possess these specialized JH receptors or the associated endocrine signaling pathways. Consequently, these compounds do not interfere with vertebrate physiology, making them ideal tools for management.

48. (C) It triggers precocious metamorphosis into miniature, sterile adults.
Anti-juvenile hormone compounds, such as the precocenes found in certain plants, act by destroying the corpora allata, the glands responsible for JH synthesis. In early instar larvae, the sudden loss of JH triggers precocious metamorphosis, where the insect prematurely transitions into a miniature adult. These precocious adults are typically sterile and unable to survive or reproduce, leading to population decline.

49. (B) The induction of a premature, lethal moult where the insect cannot shed its old head capsule.
Ecdysone agonists, like tebufenozide, mimic the action of the natural moulting hormone. When ingested by larvae, they trigger the initiation of a new moult prematurely. However, because the agonist persists and does not allow for the normal decline in hormone titer required for ecdysis, the insect becomes trapped in its old cuticle. Often, it fails to shed its head capsule, leading to starvation.

50. (A) I and II
Ecdysone agonists, also known as moulting accelerating compounds, function by binding selectively to the ecdysone receptor complex in insect cells. Methoxyfenozide is a prominent example of this class used in agriculture. Unlike natural ecdysteroids, these synthetic mimics are not easily degraded, causing a continuous hormonal signal that leads to a lethal, premature moult rather than lowering hormone titers.

51. (A) EcR/USP (Ecdysone Receptor/Ultraspiracle) heterodimer
The active form of the ecdysone receptor is a heterodimer composed of the ecdysone receptor (EcR) and the ultraspiracle protein (USP). Ecdysone agonists, such as methoxyfenozide and tebufenozide, specifically bind to this EcR/USP complex. This binding mimics the natural hormone 20-hydroxyecdysone, triggering the transcription of genes that initiate the moulting process, ultimately leading to developmental disruption and death.

52. (C) Inhibiting the synthesis of chitin in the insect cuticle.
Benzoylureas are a major class of insect growth regulators that act by inhibiting the biochemical synthesis of chitin, a vital structural component of the insect exoskeleton. By disrupting the enzyme chitin synthase or related transport processes, these compounds prevent the formation of a functional new cuticle. Consequently, the insect is unable to successfully complete the moulting process and dies.

53. (A) During ecdysis, as the new cuticle cannot withstand muscular traction
Diflubenzuron inhibits chitin synthesis, leading to the formation of a weak and malformed new cuticle beneath the old one. Mortality typically occurs during ecdysis, the physical process of shedding the old exoskeleton. Because the new cuticle lacks structural integrity, it cannot withstand the internal pressure and muscular traction required for the insect to emerge, resulting in fatal developmental failure.

54. (D) Adult insects
Chitin synthesis inhibitors are most effective against life stages that are actively producing new

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unequal chromosome segregation, leading to gametes with duplications or deficiencies of genetic material. When these unbalanced gametes fertilize normal eggs, the resulting zygotes are genetically inviable and fail to develop, thus producing a state of partial or complete sterility.

72. (C) A chemical repressor system, usually involving dietary tetracycline
The Release of Insects carrying a Dominant Lethal (RIDL) system utilizes a repressible lethal gene. In mass-rearing facilities, the lethal trait is suppressed by adding a specific chemical, typically the antibiotic tetracycline, to the insect's diet. Once the insects are released into the wild, where tetracycline is unavailable, the repressor is removed, the lethal gene is expressed, and their offspring die.

73. (D) Irradiated males retain better mating competitiveness due to lower doses
F1 sterility, or inherited sterility, is often used for Lepidopteran pests. It involves exposing the parental generation to lower doses of radiation that do not cause complete sterility but ensure their F1 offspring are sterile. A key advantage is that the lower radiation dose minimizes somatic damage, allowing the released males to remain more vigorous and competitive for mates in fields.

74. (A) Wolbachia pipientis
Cytoplasmic incompatibility is a reproductive phenomenon primarily mediated by Wolbachia pipientis, a maternally inherited endosymbiotic bacterium found in many insect species. Wolbachia manipulates the host's reproduction to facilitate its own spread through the population. In the context of pest control, this mechanism is harnessed to induce sterility when infected males mate with females that do not carry the same strain.

75. (B) III and V
Wolbachia is transmitted vertically from mothers to offspring through the egg cytoplasm, not horizontally through the air. In a suppression program using the Incompatible Insect Technique, it is essential to release only infected males. Releasing infected females would be counterproductive, as they can mate successfully with infected males and produce viable offspring, potentially replacing the wild population instead of suppressing it.

76. (B) Infected-infected mating yields viable offspring, spreading the strain
In an Incompatible Insect Technique program, the goal is to cause population crashes by ensuring incompatible matings. If Wolbachia-infected females are accidentally released alongside males, they can mate with those males to produce viable, infected offspring. This allows the Wolbachia strain to establish and spread within the wild population, eventually making all females compatible with the released males and neutralizing suppression.

77. (A) The number of released steriles relative to the estimated wild population
The overflooding ratio is a critical parameter in the planning of SIT programs. It represents the ratio of released sterile insects to the estimated number of fertile wild insects in a given area. To achieve effective population suppression, the number of sterile males must significantly exceed the number of wild males, ensuring that wild females have a high probability of mating.

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78. (C) The number of sterile males released must be increased to compensate
Mating competitiveness measures the ability of mass-reared, sterile males to successfully compete with wild males for mates. If sterile males are found to be less competitive (e.g., a value of 0.5), the overflooding ratio must be adjusted upward. By releasing a larger number of sterile insects, the program compensates for their reduced individual effectiveness, ensuring the desired level of sterility.

79. (D) Unmanaged neighbor areas act as constant sources of fertile pest reinvasion
The Sterile Insect Technique is most effective when applied as part of an Area-Wide Integrated Pest Management strategy. Because insects are highly mobile, treating only isolated fields allows fertile pests from unmanaged neighboring areas to constantly reinvade and repopulate the treated zone. An area-wide approach ensures that the entire pest population is targeted simultaneously, preventing such reinvasions and sustaining population suppression.

80. (A) Both A and R are true and R is the correct explanation of A.
SIT is most economically and biologically efficient when the wild pest population is already at a low density. In cases of high-density outbreaks,

151. (B) To render the wild population genetically incapable of transmitting disease.
Population replacement gene drives aim to alter a wild population to achieve a public health benefit. In the case of mosquitoes, the goal is to drive a gene through the population that interferes with the mosquito's ability to host or transmit a pathogen, such as malaria or dengue virus. The ultimate objective is to create a resistant population, breaking the transmission cycle.

152. (B) Applied as a knockdown tool to reduce outbreaks before deploying RNAi.
In an Area-Wide Integrated Pest Management program, chemical insecticides can be used as a strategic "knockdown" tool. When pest populations are extremely high, a targeted application of an insecticide can rapidly reduce the number of individuals to a lower level. Once the population is reduced, more specific and sustainable technologies, such as RNA interference, can be deployed to maintain long-term suppression.

153. (D) Allomone
An allomone is an allelochemical that provides an adaptive advantage to the organism that produces and emits it. In this scenario, a predator releases a chemical that deters a pest from laying eggs in the vicinity. This benefits the predator by signaling its presence and potentially reducing future competition. For the pest, the chemical acts as a signal of risk, inducing avoidance.

154. (A) Permanent species eradication alters ecosystems without global consent.
The potential use of gene drives to cause the global extinction of a species presents a major ethical dilemma. A primary concern is that such a permanent change to the biosphere could have unforeseen ecological consequences that affect multiple countries. The ethical debate centers on whether any group has the right to make a decision that permanently alters the earth's biodiversity.

155. (B) Using a "recall" drive to overwrite the drive with wild-type genetics.
Reversibility is an important safety feature being developed for gene drive technologies. A theoretical approach to reversing a gene drive involves the release of a second, "recall" drive. This new drive is designed to specifically target the initial drive allele and replace it with the original wild-type genetic sequence. By spreading through the population, the recall drive can effectively undo the modification.

156. (B) It managed polyphagous pests over a complex archipelagic environment.
The eradication of the melon fly from the Okinawa islands was a landmark success for the Sterile Insect Technique. The program was particularly challenging because it involved managing a highly mobile, polyphagous pest across a complex geography of multiple islands. Through a massive and coordinated effort of mass-rearing and aerial release, researchers were able to overcome logistically difficult environmental factors.

157. (A) It removes costs associated with mass-rearing and artificial irradiation.
The use of chemosterilant-baited traps in the field offers a potential economic advantage over traditional SIT. Instead of building and operating expensive mass-rearing facilities and irradiation centers, this method sterilizes the wild insects already present in the environment. By attracting wild pests to a bait and inducing sterility chemically, the program can reduce the logistical burden and infrastructure costs significantly.

158. (C) It acts as an endonuclease, cleaving mRNA complementary to the guide RNA.
The Argonaute protein is the core catalytic component of the RNA-induced silencing complex. Its primary role in the RNA interference pathway is to act as an endonuclease. Using the guide RNA strand as a template, Argonaute identifies the complementary messenger RNA (mRNA) sequence and performs a precise cut. This cleavage prevents the mRNA from being translated into a protein, silencing the gene.

159. (D) HIGS targets the degradation of the insect's own specific mRNA transcripts.
While both HIGS and Bt technologies involve transgenic plants, their modes of action are fundamentally different. Bt crops produce a bacterial protein toxin that physically damages the insect's midgut. In contrast, Host-Induced Gene Silencing (HIGS) operates at the molecular level by producing dsRNA that triggers the insect's own RNA interference pathway. This

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often cause frameshifts in the protein-coding sequence, leading to the production of non-functional proteins and effectively "knocking out" genes.

90. (A) II, IV, I, III
Targeted mutagenesis using CRISPR-Cas9 follows a precise molecular sequence. First, the sgRNA-Cas9 complex scans the insect genome to identify a suitable PAM sequence. Once found, the sgRNA hybridizes with the complementary target DNA. This triggers a conformational change in the Cas9 enzyme, resulting in a double-strand break. Finally, the cell's repair machinery, through NHEJ, introduces mutations while attempting to fix.

91. (B) To bias inheritance so that specific genetic alterations spread rapidly
A gene drive is a genetic technology designed to circumvent the standard laws of Mendelian inheritance. By ensuring that a specific genetic trait is passed on to nearly all offspring, rather than just half, a gene drive allows an engineered modification to spread rapidly through a wild population. This capability makes it a powerful tool for large-scale population suppression or modification.

92. (B) Heterozygotes into homozygotes for the drive allele
Homing gene drives function by using the CRISPR-Cas9 system to copy themselves from one chromosome to another within the germline cells of an individual. In a heterozygote carrying one drive allele and one wild-type allele, the Cas9 cuts the wild-type chromosome, and the cell uses the drive allele as a template for repair. This process converts the heterozygote into a drive homozygote.

93. (A) To replace the existing population with one engineered to be incapable of transmitting a specific disease or causing crop damage
Population modification, or replacement, is a gene drive strategy that aims to transform a wild population rather than eliminate it. The goal is to spread a specific beneficial trait, such as the inability to transmit a pathogen or a reduced affinity for a particular crop. By replacing the problematic wild-type insects with engineered counterparts, ecological damage or disease transmission can be halted.

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94. (C) Error-prone NHEJ repair alters the target sequence so the sgRNA can no longer recognize it.
Resistance to a CRISPR gene drive often emerges when the double-strand break created by Cas9 is repaired by Non-Homologous End Joining instead of Homology-Directed Repair. The error-prone NHEJ process introduces mutations (indels) at the target site. These small changes alter the DNA sequence such that the sgRNA can no longer bind, rendering that chromosome immune to the drive and resistance.

95. (A) I and II
Daisy-chain gene drives are designed as localized, self-limiting systems to address safety concerns about uncontrolled global spread. They consist of multiple unlinked components that sequentially drive one another. Because each "link" in the chain is eventually lost through Mendelian inheritance, the entire system is self-exhausting. This provides a way to conduct field trials or localized interventions without making permanent genetic changes.

96. (C) Utilizing a refuge strategy where a proportion of non-transgenic crops are planted nearby
To delay the evolution of resistance in pests targeted by transgenic crops, a refuge strategy is commonly employed. This involves planting a certain percentage of non-transgenic, susceptible crops alongside the engineered ones. These refuges allow a small population of susceptible insects to survive and mate with any rare resistant individuals emerging from the transgenic fields, thereby diluting the frequency of resistance alleles.

97. (B) Lowering initial wild density makes the required overflooding ratio achievable
Integrating mass trapping into a Sterile Insect Technique program provides a synergistic effect by reducing the initial density of the wild pest population. When fewer wild insects are present, the number of sterile insects required to achieve a high and effective overflooding ratio is significantly lower. This integration makes the overall program more logistically feasible and cost-effective, increasing successful suppression.

98. (D) Sequence specificity of dsRNA limits off-target lethality to beneficials
A primary benefit of RNA interference in pest management is its high level of species-specificity,

which is determined by the unique nucleotide sequence of the target gene. Because the dsRNA must match the pest's mRNA sequence to trigger silencing, it is highly unlikely to affect unrelated beneficial insects like pollinators or predators. This precision reduces environmental impact compared to broad-spectrum insecticides.

99. (A) The safe handling, transport, and use of living modified organisms (LMOs)
The Cartagena Protocol on Biosafety is a major international treaty that supplements the Convention on Biological Diversity. Its main purpose is to ensure the safe transfer, handling, and use of living modified organisms that result from modern biotechnology. The protocol focuses on protecting biological diversity from potential risks and ensuring that any transboundary movements of LMOs are conducted with consent.

100. (A) Both A and R are true and R is the correct explanation of A.
Ecological risk assessments for genetically modified insects must evaluate the possibility of horizontal gene transfer. This phenomenon involves the non-sexual movement of genetic material between different species. If an engineered construct were to move from a target pest into an unrelated wild organism, it could lead to unpredictable ecological consequences. Understanding these risks is essential for the safe deployment of technologies.

101. (A) Non-target effect
The term "non-target effect" describes any unintentional and potentially adverse impact that a pest management tool, such as a genetically engineered insect or a chemical insecticide, has on organisms other than the intended target species. Evaluating these effects is a critical part of environmental risk assessment, ensuring that the control measure does not harm beneficial insects or the broader ecosystem.

102. (D) The eradication of a keystone pest species leading to severe disruption of local food webs
While the goal of a suppression gene drive is to reduce or eliminate a pest, doing so carries ecological risks. If the target species plays a significant role in the ecosystem, such as being a primary food source for certain predators or a pollinator, its eradication could lead to the collapse of local food webs. Assessing these potential "knock-on" effects is vital.

103. (B) Genetic Engineering Appraisal Committee (GEAC) under MoEFCC
In India, the Genetic Engineering Appraisal Committee, functioning under the Ministry of Environment, Forest and Climate Change, is the apex body responsible for the biosafety evaluation of genetically engineered organisms. The GEAC formulates guidelines and reviews applications for the environmental release of GE insects, ensuring that all research and deployments comply with national biosafety standards and environmental laws.

104. (C) To prevent the accidental escape and unintended environmental release of transgenic organisms
Containment strategies in biotechnology research involve a combination of physical, biological, and procedural barriers designed to keep transgenic organisms confined within the laboratory or greenhouse. The fundamental goal is to prevent the accidental escape of genetically modified insects into the wild, where they could have unintended ecological impacts or interfere with natural populations before they have been fully assessed.

105. (A) P-4, Q-2, R-1, S-3
Biosafety and risk assessment involve several key concepts. Off-target mutations are unintended genomic changes at non-target sites. Containment includes the barriers that prevent transgenic escape. Reversibility is the theoretical ability to undo or overwrite a genetic intervention. Horizontal gene transfer refers to the movement of DNA between different species. Together, these factors are evaluated to ensure the safe application of technologies.

106. (A) They allow researchers to genetically distinguish between wild-type and mass-released modified individuals in field samples.
Molecular markers, such as fluorescent proteins or specific DNA sequences, are integrated into the genome of modified insects to serve as identifiable tags. During post-release monitoring, these markers allow scientists to easily distinguish the released individuals from the native wild population. This information is essential for calculating overflooding ratios, tracking the spread of genetic traits, and assessing the overall performance.

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107. (B) Transparent risk communication and robust stakeholder engagement
Public acceptance of novel genetic pest management technologies is deeply dependent on transparency and trust. Effective programs prioritize open communication about the potential risks and benefits, coupled with active engagement with stakeholders, including local communities, farmers, and environmental groups. By involving the public in decision-making and addressing their concerns, researchers and regulatory bodies can build necessary social license.

108. (B) The right of humans to permanently alter or eliminate entire wild species from the biosphere.
The prospect of using gene drives to achieve total eradication of a species raises profound ethical questions. The central debate focuses on whether humans have the moral authority to permanently remove a wild species from the planet and how such an action might impact the intrinsic value of biodiversity. These discussions involve complex considerations of human health and environmental stewardship.

109. (A) Engineering the drive into a highly specific synthetic genetic background that is lethal in wild outcrosses.
Biological containment involves genetic designs that limit the survival or spread of an organism outside the laboratory. One such strategy is engineering the gene drive into a specialized genetic background that is only viable under specific laboratory conditions or when paired with specific companion genes. If an insect carrying such a drive escapes and mates with wild-type individuals, the offspring are inviable.

110. (A) I and II
The integration of genomics into chemical ecology has revolutionized pest management. Genomic data allows for the discovery of olfactory receptors that can be targeted by new attractants or repellents. Furthermore, tools like CRISPR-Cas9 are invaluable for validating the function of specific genes involved in the production or perception of pheromones, providing a deeper understanding of molecular mechanisms underlying behavior and communication.

111. (D) Specific Odorant Binding Proteins and Receptors in the antennae
Insects detect and interpret complex pheromone blends through a sophisticated olfactory system. Specific odorant binding proteins in the antennal sensilla capture and transport pheromone molecules to specialized odorant receptors. The brain then processes signals from multiple receptor types, allowing the insect to accurately perceive the precise ratio of components in a blend, which is essential for distinguishing conspecific mates.

112. (C) They are emitted by non-living material, such as decaying wood.
Apneumones are a unique class of allelochemicals that are emitted by non-living substrates rather than by a living organism. These substances elicit a behavioral or physiological response that is beneficial to the receiving organism. For example, odors from decaying meat or rotting wood that attract necrophagous or saproxylic insects are classified as apneumones, serving as vital cues for finding food.

113. (B) Aggregation pheromone
A chemical that induces individuals of both sexes of the same species to gather at a specific location, such as a newly found food source or a potential nesting site, is classified as an aggregation pheromone. These signals facilitate group behaviors that can be advantageous for defense, resource exploitation, or locating mates. They are widely used in management for monitoring various beetles.

114. (D) Only specific enantiomers are active; others may be inactive or repellent.
The stereochemistry of a pheromone is often critical for its biological activity. Insects typically possess highly specific olfactory receptors that can distinguish between different enantiomers of the same chemical compound. In many cases, only one specific enantiomer will attract the insect, while others may have no effect or even act as a repellent. Accurate synthesis of the correct form is essential.

115. (A) I, II, IV and V
Pheromone trap efficiency depends on several interconnected factors. Visual cues can enhance attraction, while the physical state of the trap, such as a dust-covered sticky liner, can reduce capture rates. It is also essential that

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programs often use chemical insecticides or other methods to initially reduce the population. This makes it possible to achieve an effective overflooding ratio with a manageable number of released sterile insects, which would otherwise be logistically impossible.

81. (B) It cleaves long double-stranded RNA (dsRNA) into short interfering RNAs (siRNAs).
Dicer is a specialized RNase III-like enzyme that plays a fundamental role in the initiation phase of the RNA interference pathway. Its primary function is to recognize long double-stranded RNA molecules that enter the cell and cleave them into smaller fragments, typically 21 to 23 base pairs in length. These fragments, known as short interfering RNAs, serve as the templates.

82. (D) The RNA-induced silencing complex (RISC)
The RNA-induced silencing complex is a multi-protein assembly that is central to the effector phase of RNA interference. Once siRNAs are produced, they are loaded into RISC, where one strand is retained as a guide. This guide strand enables RISC to identify and bind to complementary messenger RNA (mRNA) molecules. Upon binding, the complex facilitates the degradation of target mRNA.

83. (A) Coleoptera
The efficiency of RNA interference varies significantly among different insect groups. Beetles, belonging to the order Coleoptera, are widely recognized for possessing a highly robust and sensitive systemic RNAi response. In many coleopteran species, the silencing signal can easily spread from the gut to other tissues, making them ideal candidates for developing RNAi-based pest control technologies through the ingestion of dsRNA.

84. (C) Engineering the crop plant to express dsRNA targeting an essential gene of the insect pest
Host-Induced Gene Silencing is a transgenic approach where crop plants are genetically engineered to produce double-stranded RNA molecules. These dsRNAs are designed to match the sequence of a vital gene in a specific target insect. When the pest feeds on the transgenic plant, it ingests the dsRNA, which then triggers the RNAi pathway within the insect, leading to silencing.

85. (A) P-4, Q-2, R-3, S-1
RNA interference and genome editing involve specific molecular components and applications. HIGS refers to the expression of dsRNA in transgenic plants to target pests. SIGS involves the topical application of dsRNA. Dicer is the enzyme that processes long dsRNA into siRNAs. Argonaute is the catalytic endonuclease within the RISC complex that cleaves target mRNA. Together, these form the basis of biotechnology.

86. (D) Naked dsRNA is prone to rapid degradation by UV light and nucleases
A major hurdle for the effectiveness of Spray-Induced Gene Silencing (SIGS) is the instability of double-stranded RNA in open environments. When applied topically to crops, "naked" dsRNA is quickly broken down by ultraviolet radiation from sunlight and by various nucleases present on the leaf surface or in the soil. To overcome this, researchers are developing protective delivery systems like nanoparticles.

87. (B) To direct the Cas9 nuclease to the specific complementary genomic target sequence
In the CRISPR-Cas9 system, the single guide RNA is a synthetic molecule that provides the necessary specificity for genome editing. It consists of a sequence that is complementary to the target DNA. By forming a complex with the Cas9 nuclease, the sgRNA guides the enzyme to the exact location in the genome, where the Cas9 then performs a precise double-strand break.

88. (C) Protospacer Adjacent Motif (PAM)
The Protospacer Adjacent Motif is a short, specific DNA sequence, typically 2-6 base pairs long, that must be present immediately following the DNA sequence targeted by the Cas9 nuclease. Cas9 uses the PAM to distinguish self from non-self and to initiate the binding and unwinding of the DNA helix. Without the correct PAM, the CRISPR-Cas9 complex cannot cleave target DNA.

89. (D) It is error-prone and typically introduces insertions or deletions (indels) that disrupt gene function.
After CRISPR-Cas9 creates a double-strand break, the cell's Non-Homologous End Joining repair pathway often reunites the ends. However, NHEJ is inherently error-prone and frequently results in the addition or loss of small numbers of nucleotides, known as indels. These mutations

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with the wild population. For the program to succeed, the sterilization process must not significantly impair the males' health, flight ability, or mating behavior. They must be able to disperse throughout the target area and successfully compete with wild males to find and mate with females.

125. (C) 10^5
To achieve the desired level of population suppression in an SIT program, the overflooding ratio must be carefully maintained. If the estimated wild male population is 10^4 and a ratio of 10:1 (sterile to wild) is required, the release number is calculated by multiplying the wild population by the ratio. In this case, releasing 10^5 competitive sterile males is necessary.

126. (C) The ratio of adjacent versus alternate chromosome segregation.
In individuals with a reciprocal translocation, chromosomes can segregate in different ways during meiosis. Alternate segregation produces balanced gametes that lead to viable offspring. However, adjacent segregation results in unbalanced gametes with duplications and deletions of genetic segments, leading to inviable zygotes. The level of sterility is determined by the relative frequency of these patterns, often around 50% for translocations.

127. (D) Cytoplasmic Incompatibility via Wolbachia
Cytoplasmic incompatibility is a specialized form of reproductive interference caused by the bacterium Wolbachia. It occurs when a Wolbachia-infected male mates with a female that is either uninfected or carries a different, incompatible strain. The interaction between the sperm and the egg prevents successful embryonic development, leading to early embryo death. This natural phenomenon is harnessed in management to suppress populations.

128. (C) SID-1 like proteins
The success of systemic RNA interference depends on the ability of cells to take up double-stranded RNA from the surrounding environment. In many insects, this process is facilitated by specialized transmembrane proteins known as SID-1 like (Systemic RNA Interference Defective) proteins. These proteins act as channels that allow the entry of dsRNA into the cytoplasm, where it triggers intracellular silencing.

129. (B) Lepidoptera express active midgut dsRNases that degrade ingested RNA.
The high susceptibility of beetles to ingested dsRNA makes them excellent targets for RNAi. In contrast, many caterpillars are less responsive because their midgut environment contains high levels of double-stranded RNA-degrading enzymes, or dsRNases. These enzymes break down the ingested dsRNA before it can be absorbed by the cells, effectively neutralizing the silencing signal and protecting the insect from effects.

130. (B) Using bioinformatic alignments to ensure the sequence is unique.
To ensure the precision of CRISPR-Cas9 genome editing, it is crucial to select a target sequence that is unique within the pest's genome. Before starting physical experiments, researchers use bioinformatic tools to align potential sgRNA sequences against the entire genomic database of the target organism and related non-target species. This computational analysis identifies sequences that could lead to unintended off-target cleavage.

131. (A) Collapse of the population occurs due to the lack of fertile females.
When a gene drive designed to disrupt a female fertility gene spreads to fixation, every individual in the population will eventually carry the drive allele. In this scenario, females will be homozygous for the mutation, rendering them sterile or inviable. As the number of fertile females drops to zero, the population loses its ability to reproduce and sustain itself, leading to collapse.

132. (C) Complete Protection Time (CPT)
In the laboratory and field evaluation of insect repellents, the standard metric used to measure performance is the Complete Protection Time. CPT is defined as the duration of time from the initial application of the repellent until the first confirmed landing or bite by the target insect. This value helps consumers understand how long a specific formulation remains effective before needing reapplication.

133. (A) Desmodium acts as a repellent (push), while Napier grass acts as an attractant (pull).
The Push-Pull strategy uses ecological interactions to manage cereal stemborers. Desmodium is intercropped with maize and

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releases volatile organic compounds that repel (push) moths away from the main crop. Meanwhile, Napier grass is planted as a border crop; it produces more attractive volatiles that lure (pull) moths to oviposit on its leaves, which then trap the emerging larvae.

134. (D) Laboratory adaptation of the strain leading to loss of field competitiveness.
A major challenge for long-term SIT programs is maintaining the quality of mass-reared insects. Over many generations in a controlled facility, the insect strain may undergo laboratory adaptation, selecting for traits that are beneficial in a cage but detrimental in the wild. This can lead to a loss of field competitiveness, where sterile males are no longer effective at mating.

135. (B) A fatal mutation in the wild that is suppressed by a laboratory additive.
In the RIDL system, a conditional lethal mutation is one that only causes death under specific environmental conditions. In the mass-rearing facility, the lethal effect is "switched off" or suppressed by providing a specific dietary additive, such as tetracycline. Once the insects are released into the wild where the additive is absent, the lethal trait becomes active, ensuring offspring death.

136. (C) Frameshift mutations caused by indels, leading to premature stop codons.
When the cell repairs a CRISPR-induced double-strand break using Non-Homologous End Joining, it often introduces small insertions or deletions. If these indels occur within a protein-coding region and are not a multiple of three nucleotides, they cause a frameshift mutation. This shift alters the reading frame during translation, leading to the appearance of premature stop codons and truncated proteins.

137. (D) The drive allele could cross political borders and spread globally.
Global homing gene drives are designed to spread a genetic trait through an entire species. A significant biosafety and geopolitical concern is that once such a drive is released, it is not easily contained. Because insects are highly mobile and do not respect international boundaries, the drive allele could spread from the release country to neighboring nations, causing unintended ecological changes.

138. (A) Preventing feeding damage while preserving natural predator populations.
Integrating botanical antifeedants into an IPM program offers a selective approach to pest management. By deterring pests from feeding on the crop without necessarily killing them, these compounds significantly reduce economic damage. Because many botanical antifeedants have low toxicity to non-target organisms, they allow for the continued survival and activity of natural enemies like predators, contributing to sustainable suppression.

139. (B) Volatiles facilitate long-range communication; low-volatiles mediate contact.
The volatility of a semiochemical dictates its ecological function. Highly volatile compounds can travel long distances through the air, forming odor plumes that facilitate long-range communication, such as attracting mates or locating hosts. In contrast, low-volatility compounds tend to remain on surfaces and are typically used for short-range or contact communication, such as trail marking, host acceptance, or social recognition.

140. (B) Corpora allata
In most insect species, the corpora allata are the primary site of juvenile hormone biosynthesis. These paired endocrine glands receive signals from the brain and respond by secreting JH into the hemolymph. The regulation of JH production is vital for controlling the timing of moulting and metamorphosis. Disruption of these glands or the hormone they produce is a target for management.

141. (A) Most adult parasitoids and predators do not actively moult, thus minimizing their susceptibility to CSIs.
Chitin Synthesis Inhibitors are highly compatible with adult biological control agents because their mode of action is specific to the moulting process. Since adult parasitoids and predators have already completed their development and do not undergo further moults, they lack the active chitin synthesis targeted by these chemicals. This selectivity allows the beneficial adults to continue their role in suppressing populations.

142. (C) Mated females from untreated neighbors migrate into the field to lay eggs.
Mating disruption is most successful when applied across a large, continuous area. If the

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strategy is used only in a small, isolated field, its effectiveness is often compromised by the movement of insects. While the pheromones may prevent local mating, already-mated females from surrounding untreated areas can easily fly into the treated field and lay fertile eggs, leading to damage.

143. (D) Releasing male mosquitoes infected with a specific, incompatible Wolbachia strain (Incompatible Insect Technique).
The Incompatible Insect Technique is a biocontrol method that uses the bacterium Wolbachia to manage mosquito populations. By releasing large numbers of male mosquitoes infected with a specific strain of Wolbachia, researchers can induce cytoplasmic incompatibility when these males mate with wild, uninfected females. This incompatibility prevents development of viable offspring, leading to a significant reduction in the mosquito population.

144. (C) Spray-Induced Gene Silencing (SIGS)
Spray-Induced Gene Silencing refers to the exogenous application of double-stranded RNA molecules directly onto plants or insect habitats to manage pests. In this approach, the dsRNA is formulated as a spray and is subsequently ingested by the target insect. Once inside the pest, the dsRNA triggers the RNAi pathway, silencing an essential gene and leading to mortality or reduced fitness.

145. (B) The presence of a donor DNA template possessing sequence homology flanking the break site.
Homology-Directed Repair is a precise DNA repair mechanism that cells use to fix double-strand breaks. For HDR to occur following a CRISPR-Cas9 cut, a donor DNA template must be available. This template must contain sequences that are identical (homologous) to the DNA flanking the break site. Researchers can provide synthetic donor templates to introduce specific changes with high accuracy.

146. (D) The reduction in survival, reproductive capacity, or mating competitiveness compared to wild-type individuals.
In the context of genetically modified insects, fitness costs refer to any negative impacts that the genetic modification has on the insect's overall biological performance. This can include a decrease in lifespan, reduced fertility, or lower mating competitiveness in the wild. Assessing these costs is crucial for predicting how long a modification will persist and how many insects need to be released.

147. (A) Controlled, slow release of the active ingredient over an extended period.
Microencapsulation is a formulation technology used to enclose pheromones or other semiochemicals within tiny polymer shells. The primary goal of this design is to regulate the evaporation and release of the active ingredient into the environment. By providing a controlled, slow release, microencapsulation ensures that the chemical remains effective in the field for a longer duration, improving pest control efficiency.

148. (C) Using a highly impure synthetic blend that contains antagonistic impurities.
The specificity of insect pheromone detection means that the chemical purity of a lure is extremely important. Synthetic pheromone blends that contain impurities or the wrong ratio of components can be significantly less effective. In some cases, specific chemical impurities or minor components from a different species can act as antagonists, actively repelling the target insect and drastically reducing trap efficiency.

149. (A) Application must occur when endogenous JH titers naturally drop to zero.
Juvenile hormone mimics are most effective when applied at specific "sensitive periods" in an insect's life cycle. This typically occurs during the final larval instar or just before pupation, when the natural levels of juvenile hormone in the insect's body drop to zero. By introducing a mimic at this precise moment, the treatment prevents the insect from transitioning correctly into maturity.

150. (D) SIT is species-specific and poses minimal risk to non-target organisms.
A profound ecological advantage of the Sterile Insect Technique is its extreme selectivity. Because the strategy relies on released insects mating only with members of their own species, it has no direct effect on other organisms in the environment. This high degree of species-specificity ensures that beneficial insects, such as pollinators and natural enemies, are not harmed, making it an environmentally friendly alternative.

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the pheromone release rate remains within a biologically active range. Furthermore, trap placement must ensure that the odor plume effectively reaches the target population based on wind.

116. (C) Y-tube olfactometer or wind tunnel test
To confirm the behavioral response of an insect to a suspected pheromone, researchers use specialized laboratory assays. The Y-tube olfactometer allows insects to choose between a clean air stream and one containing the chemical stimulus. Wind tunnel tests provide a more complex environment where insects can exhibit upwind flight and orientation. These assays are crucial for validating attractiveness before field testing.

117. (A) It mimics the volatile profile of decaying food or bird droppings.
Ammonium bicarbonate is commonly used in traps as a food-based attractant for various fruit flies. As it breaks down, it releases ammonia, which mimics the odors associated with natural protein sources such as bird droppings or microbial fermentation. Since female fruit flies require protein for egg development, they are strongly drawn to these nitrogenous volatiles, making ammonium bicarbonate an effective lure.

118. (D) Feeding deterrent (antifeedant)
A substance that allows an insect to initiate contact but subsequently inhibits prolonged feeding is classified as an antifeedant or feeding deterrent. These compounds act on the insect's gustatory receptors, signaling the pest to stop consuming the plant tissue before significant damage occurs. Unlike insecticides that kill upon contact, antifeedants primarily protect the crop by modifying the insect's behavior through deterrence.

119. (B) Steroid derivative (Ecdysteroid)
Ecdysone belongs to a class of chemical compounds known as ecdysteroids, which are steroid-based hormones derived from cholesterol or other plant-based sterols. Because insects cannot synthesize the steroid ring structure from scratch, they must obtain precursors from their diet. Once synthesized in the prothoracic glands, ecdysone serves as a critical signaling molecule that regulates growth, moulting, and metamorphosis throughout development.

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120. (C) To maintain the status quo, ensuring the next moult results in another larval stage rather than a pupa or adult
Juvenile hormone plays a "status quo" role in insect development. When present in high concentrations during a moult triggered by ecdysone, JH ensures that the insect retains its juvenile characteristics and undergoes another larval-to-larval transition. This prevents premature metamorphosis into pupal or adult stages. As development progresses toward the final instar, JH levels naturally decline, allowing maturity and completion.

121. (D) Pupa to adult emergence
Methoprene is a juvenile hormone analog that does not typically kill mosquito larvae directly. Instead, it allows them to grow and pupate normally. The lethal effect occurs during the pupal-to-adult transition, where the presence of the JH mimic disrupts the final stages of metamorphosis. Consequently, the mosquitoes are unable to successfully emerge from their pupal cases as viable adults.

122. (A) It has complex mixtures of biochemicals with diverse modes of action.
Azadirachtin, the primary active ingredient in neem extracts, is rarely associated with rapid pest resistance because it is part of a complex mixture of many limonoids and other phytochemicals. These compounds exert multiple biological effects, including antifeedancy, growth regulation, and reproductive disruption. Because the pest is exposed to several different modes of action simultaneously, resistance evolution is much less likely.

123. (B) Nucleic acid (DNA/RNA) synthesis and transcription in germ cells.
As an antimetabolite, 5-fluorouracil functions as a structural analog of uracil, an essential component of RNA. When present in the insect's system, it interferes with the enzymes involved in the synthesis of nucleotides and is incorporated into nucleic acid strands. This disruption severely impairs DNA replication and RNA transcription, particularly in the rapidly dividing germ cells of reproductive organs.

124. (B) Dispersing and actively seeking out wild females to mate
The Sterile Insect Technique relies entirely on the ability of released sterile males to interact

leads to the specific degradation of the insect's mRNA.

160. (C) Implementing a tiered assessment of impacts on non-targets and food webs.
Establishing a robust biosafety framework for the release of genetically modified insects requires a systematic and scientific approach. A critical element is the implementation of a tiered risk assessment. This process involves laboratory and semi-field studies to evaluate potential impacts on non-target organisms, such as pollinators and predators, and to assess how the modification might disrupt food webs.

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Boundary.

2002

32. Which of the following factors is least likely to permanently influence the General Equilibrium Position (GEP) of an endemic pest in an agro-ecosystem?
(A) Introduction of a new, highly susceptible crop variety.
(B) Establishment of a novel parasitoid species in the region.
(C) A single, localized application of a short-lived botanical insecticide.
(D) Long-term macro-climatic shifts due to climate change.

2021

33. The foundational economic concepts of the Economic Injury Level (EIL) and the Economic Threshold (ETL) were first formalized and introduced by:
(A) R.H. Painter
(B) V.M. Stern and colleagues
(C) Rachel Carson
(D) E.F. Knipling

2019

34. In the standard equation for calculating the Economic Injury Level (EIL), $EIL = \frac{C}{V \times I \times D \times K}$, what does the variable 'C' represent?
(A) Crop susceptibility index
(B) Coefficient of pest feeding efficiency
(C) Carrying capacity of the agro-ecosystem
(D) Cost of the pest management intervention per unit area

2003

35. Consider the following statements regarding the Economic Injury Level (EIL):
I. An increase in pest management costs (C) will increase the calculated EIL.
II. An increase in the market value of the crop (V) will decrease the calculated EIL.
III. The EIL represents the pest density where control costs equal the value of damage prevented.
IV. The EIL is universally static for a specific pest and never changes.
V. A higher degree of crop tolerance to injury (D) results in a lower EIL.
Which of the above statement(s) is/are correct?
(A) I, II and III
(B) II, IV and V
(C) I, III and V
(D) I, II, III and V

2014

36. An unexpected and significant increase in the global market value of a specific crop will functionally have what effect on the Economic Injury Level (EIL) for pests infesting that crop?
(A) It will increase the EIL, allowing farmers to tolerate more pests.
(B) It will completely eliminate the relevance of the EIL.
(C) It will decrease the EIL, requiring earlier and more stringent pest interventions.
(D) It will have no mathematical effect on the EIL calculation.

2004

37. If a conservation biological control program significantly reduces a pest's per-capita feeding efficiency (I), how is the standard EIL functionally impacted?
(A) The EIL increases, meaning a higher pest density is required to cause economic injury.
(B) The EIL decreases, meaning even lower pest densities will cause economic injury.
(C) The EIL remains unchanged, but the ETL shifts downward.
(D) The EIL becomes negative, indicating an unmanageable pest outbreak.

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2001

38. Identify the INCORRECT statement regarding the biotic and abiotic factors influencing the Economic Injury Level (EIL):
(A) Highly susceptible crop varieties generally possess a lower EIL compared to tolerant varieties.
(B) Unfavorable weather conditions causing plant moisture stress can lower the EIL for defoliating pests.
(C) Increased efficacy of the chosen control measure (K) proportionally lowers the EIL.
(D) The EIL is completely independent of the crop's physiological growth stage during infestation.

2023

39. The Economic Injury Level (EIL) metric is typically expressed in practical agricultural terms as:
(A) The monetary value of the crop per hectare.
(B) The number of insects or amount of injury per unit of crop or area.
(C) The percentage of pesticide active ingredient required.

primary pests.
(C) Pest resistance, resurgence, and secondary pest outbreaks.
(D) Increased soil fertility leading to excessive vegetative crop growth.

2017

9. In the historical evolution of pest management, early cultural practices primarily focused on:
(A) Utilizing and developing genetically engineered insect-resistant crop varieties.
(B) Synthesizing neurotoxic chemicals for prophylactic field application strategies.
(C) Mass rearing and inundative release of sterile male insects in the environment.
(D) Agronomic manipulations such as adjusting planting dates and sanitation.

2015

10. In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:
Assertion (A): The early pesticide era successfully eradicated numerous key agricultural pests permanently.
Reason (R): Broad-spectrum pesticides simultaneously eliminated natural enemy populations, leading to severe ecological imbalances.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2018

11. A primary limitation of early cultural pest management practices, prior to the advent of modern IPM, was that they:
(A) Were generally found to be highly toxic to several non-target mammalian species.
(B) Often required region-wide synchronization to be effectively preventative.
(C) Resulted in immediate target-site resistance in most local insect populations.
(D) Functioned only under artificial or strictly controlled greenhouse conditions.

2017

12. The conceptual transition from "pest control" to "pest management" historically signified an academic shift toward:
(A) The absolute eradication of all herbivorous insects in the local ecosystem.
(B) Accepting the permanent presence of pests and maintaining them at tolerable levels.
(C) Maximizing crop yields irrespective of the ecological and economic inputs required.
(D) Relying exclusively on botanical and microbial insecticides for suppression.

2019

13. The underlying ecological philosophy of Integrated Pest Management (IPM) is primarily focused on:
(A) Using agro-ecosystem dynamics and natural mortality to regulate pests.
(B) Sterilizing target pests to drive local populations to total extinction.
(C) Modifying the genetic structure of non-target organisms in the habitat.
(D) Eliminating all synthetic chemicals from commercial agricultural production.

2013

14. Which of the following represents a core socio-economic objective of an implemented IPM program?
(A) Reducing the manual labor required for standard crop harvesting practices.
(B) Ensuring the complete physical destruction of all potential pest habitats nearby.
(C) Optimizing the cost-benefit ratio of pest interventions while safeguarding health.
(D) Subsidizing the cost of broad-spectrum chemical fertilizers used in the field.

2003

15. Consider the following statements regarding the core principles of Integrated Pest Management (IPM):
I. It relies heavily on prophylactic, calendar-based pesticide applications.
II. It integrates multiple compatible tactics to suppress pests.
III. It aims to maintain pest populations below the Economic Injury Level (EIL).
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) II only

2014

16. IPM programs intentionally tolerate a certain sub-economic level of pest presence primarily because:
(A) Total eradication is chemically impossible in open agricultural systems.

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CHAPTER 09
Integrated Pest Management

2008

1. What primarily defines a 'key pest' within an agricultural ecosystem?
(A) Its population fluctuates randomly but rarely causes economic damage.
(B) Its General Equilibrium Position (GEP) lies consistently above the Economic Injury Level (EIL).
(C) It causes sudden, widespread outbreaks due to highly favorable weather.
(D) It only occurs in isolated geographic regions with high humidity.

2023

2. Which pest category describes insects whose General Equilibrium Position (GEP) is typically well below the Economic Injury Level (EIL), but whose population occasionally crosses the EIL under unusually favorable environmental conditions?
(A) Endemic pests
(B) Epidemic pests
(C) Regular pests
(D) Occasional pests

2016

3. Epidemic pests in agricultural systems are most accurately characterized by their tendency to:
(A) Exhibit sudden, severe, and widespread population explosions across large areas.
(B) Cause severe, localized damage consistently every cropping season.
(C) Maintain a static population density irrespective of environmental changes.
(D) Rely exclusively on alternative weed hosts throughout the year.

2013

4. Identify the INCORRECT statement regarding the ecological status of endemic pests:
(A) They are continuously present in a specific locality or region year after year.
(B) Their occurrence is often closely tied to specific microclimatic or soil conditions.
(C) They consistently migrate across continental borders during their adult stage.
(D) They generally cause low to moderate but consistent economic damage.

2004

5. If a pest population remains functionally below the Economic Threshold Level (ETL) but is consistently found in the field during the vegetative stage of the crop, it is ecologically classified as a:
(A) Sub-economic pest
(B) Key pest
(C) Sporadic pest
(D) Migratory pest

2006

6. All of the following are characteristic features of regular pests EXCEPT:
(A) They have a very close association with their specific host crop.
(B) They occur frequently and cause predictable levels of damage.
(C) Their management requires routine monitoring during the susceptible crop stages.
(D) They are absent from the ecosystem until introduced by extreme weather events.

2017

7. The paradigm shift toward modern Integrated Pest Management (IPM) was primarily catalyzed by the adverse environmental and agricultural consequences associated with:
(A) The sudden, widespread introduction of transgenic crops into the market.
(B) The unilateral reliance on synthetic broad-spectrum insecticides.
(C) The implementation of clinical biological control programs globally.
(D) The promotion of monoculture over polyculture cropping systems.

2017

8. The systemic failure characterizing the late "pesticide era" was fundamentally driven by the accelerated development of:
(A) Decreased crop nutritional quality and reduced market value.
(B) Enhanced predator populations displacing

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(B) Relative sampling methods, such as sweep netting, provide estimates of population density relative to previous samples.
(C) Light traps provide an exact absolute estimate of the localized larval population in the soil.
(D) Indirect sampling measures the amount of crop damage or products left by the pest rather than the insects themselves.

2016

25. Consider the following statements concerning pest surveillance and monitoring:
I. Pheromone traps are highly species-specific and useful for early detection.
II. Systematic sampling guarantees that every single plant in a field is inspected.
III. Action thresholds remain perfectly static regardless of crop growth stage.
IV. Remote sensing is increasingly used for large-scale pest damage detection.
Which of the above statement(s) is/are INCORRECT?
(A) I and IV
(B) II and III
(C) I, III and IV
(D) I, II and IV

2018

26. A fixed-precision sampling plan in pest ecology is most appropriately utilized when the primary objective is to:
(A) Obtain highly accurate population density estimates for academic research or modeling.
(B) Quickly decide whether to apply a pesticide based on a simple threshold.
(C) Eradicate the pest population using mechanical traps.
(D) Determine the market value of the harvested crop yield.

2011

27. The General Equilibrium Position (GEP) of a pest population is conceptually defined as:
(A) The absolute highest population density a species can reach before starvation.
(B) The average long-term pest density over time without permanent environment changes.
(C) The point at which natural enemies completely eradicate the pest population.
(D) The exact population level at which economic damage unequivocally begins.

2018

28. In pest population dynamics, the 'Damage Boundary' represents the precise pest population density at which:
(A) The cost of pest control equals the financial benefit derived from the control.
(B) Measurable crop injury begins to translate into measurable yield loss.
(C) The pest population collapses due to excessive intraspecific competition.
(D) Natural enemies are no longer able to regulate the pest population.

2025

29. How does the Damage Boundary conceptually differ from the Economic Threshold Level (ETL)?
(A) The Damage Boundary indicates the onset of yield loss, whereas the ETL indicates when management action must be taken to prevent reaching the EIL.
(B) The Damage Boundary is always significantly higher than the ETL in field settings.
(C) The ETL relies strictly on plant responses, whereas the Damage Boundary relies on economics.
(D) The Damage Boundary applies only to pathogens, while the ETL applies only to insects.

NODIA

2011

30. Identify the correct statement relating to the General Equilibrium Position (GEP):
(A) Chemical insecticide applications permanently alter the long-term GEP of a pest population.
(B) A key pest is characterized by a GEP that never crosses the Damage Boundary.
(C) An introduction of a highly effective, permanent classical biocontrol agent will permanently lower a pest's GEP.
(D) The GEP fluctuates wildly daily based on minor humidity changes.

2025

31. For an insect herbivore to be ecologically classified as a 'sub-economic pest', its General Equilibrium Position (GEP) must inherently be:
(A) Equal to the Economic Injury Level (EIL).
(B) Far above the Economic Injury Level (EIL) and Damage Boundary.
(C) Exactly equivalent to the Economic Threshold Level (ETL).
(D) Consistently below the Economic Injury Level (EIL) and rarely reaching the Damage

pest development and survival are collectively termed:
(A) Classical biological control
(B) Behavioral control
(C) Autocidal control
(D) Cultural control

2006

48. The cultural practice of trap cropping operates primarily on the ecological principle of:
(A) Providing absolute physical exclusion from the main crop foliage.
(B) Emitting synthetic pheromones to cause mating disruption in pests.
(C) Offering a highly preferred alternative host to draw pests away from the main crop.
(D) Utilizing sterile insects to outcompete fertile wild males in the field.

2005

49. Altering sowing dates is a widely recommended cultural control tactic that manages pest populations primarily by:
(A) Changing the genetic resistance profile of the planted seeds.
(B) Inducing asynchrony between the susceptible stage of the crop and the peak emergence of the pest.
(C) Increasing the ambient soil temperature to lethal levels for pest pupae residing in the dirt.
(D) Eliminating the need for any subsequent nutrient management or fertilization.

2013

50. Match the cultural control tactics in List I with their primary mechanism of action in List II:
List I: (Control Tactics)
P. Crop rotation
Q. Field sanitation
R. High seeding rate
S. Trap cropping
List II: (Mechanism of Action)
1. Removes overwintering sites and crop residues
2. Compensates for anticipated early-season pest damage
3. Disrupts the continuity of food supply for monophagous pests
4. Concentrates pest populations into restricted areas for targeted destruction
(A) P-3, Q-1, R-2, S-4
(B) P-1, Q-3, R-4, S-2
(C) P-3, Q-2, R-1, S-4
(D) P-2, Q-4, R-3, S-1

2024

51. Rigorous sanitation practices in agricultural fields primarily disrupt the pest life cycle by:
(A) Destroying crop residues that serve as critical overwintering or diapausing sites.
(B) Directly altering the physical morphology of the host plant.
(C) Introducing novel entomopathogenic fungi into the soil profile.
(D) Enhancing the nutritional quality of the soil to promote rapid vegetative growth.

2009

52. Identify the INCORRECT statement regarding the use of crop rotation in integrated pest management:
(A) It is highly effective against soil-dwelling pests with limited mobility.
(B) It disrupts the life cycle of pests that possess a narrow host range.
(C) It is most successful when used against highly polyphagous, highly mobile flying insects.
(D) It provides supplementary benefits such as improved soil health and weed suppression.

2017

53. A primary ecological advantage of utilizing intercropping over extensive monoculture in pest management is that intercropping:
(A) Generates a more complex micro-environment that disrupts pest host-finding behavior.
(B) Completely eliminates the necessity for biological control agents.
(C) Ensures that all planted crops mature simultaneously for easier chemical application.
(D) Guarantees a permanent reduction in the genetic diversity of the pest population.

2014

54. The application of specialized temperature treatments to disinfest stored agricultural grains is formally classified as an example of:
(A) Chemical pest control
(B) Behavioral pest control
(C) Cultural pest control
(D) Physical pest control

2005

55. Arrange the following grain storage temperature treatments in increasing order of operational heat applied:
I. Refrigerated cold storage
II. Sun drying

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(D) The total volume of spray fluid needed per acre.

2024

40. In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:

Assertion (A): The Economic Threshold Level (ETL) is always set at a pest population density strictly lower than the Economic Injury Level (EIL).

Reason (R): Intervening at the ETL allows sufficient time for control measures to take effect before the pest population reaches the EIL and causes economic damage.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2011

41. The Economic Threshold Level (ETL), often referred to as the Action Threshold, is conceptually defined as the pest population density at which:

(A) Natural enemies achieve maximum regulatory control over the pest.
(B) The crop begins to visually wilt due to excessive insect feeding.
(C) The financial cost of pesticide application outweighs the crop yield value.
(D) Management action must be initiated to prevent the population from reaching the EIL.

2014

42. The primary operational difference between the Economic Injury Level (EIL) and the Economic Threshold Level (ETL) is that:

(A) The ETL is a practical decision point for intervention, while the EIL is the damage limit to be avoided.
(B) The EIL is a predictive warning tool, while the ETL measures retrospective economic failure in the field.
(C) The EIL is an economic parameter indicating zero profit, while the ETL is a strictly biological parameter.
(D) The ETL only applies to vector-borne diseases, while the EIL applies exclusively to defoliating insects.

2015

43. In active field applications, successfully utilizing the ETL for decision-making fundamentally requires continuous and accurate:

(A) Deep soil chemical profiling
(B) Field scouting and pest population monitoring
(C) Assessment of global pesticide market prices
(D) Genetic sequencing of the local pest population

2021

44. Which of the following factors is NOT typically used to dynamically adjust the practical Economic Threshold Level (ETL) of a pest during an active growing season?

(A) Changes in the market price of the harvested crop.
(B) The current physiological growth stage of the crop.
(C) The real-time abundance of effective natural enemies in the field.
(D) The global historical evolutionary origin of the pest species.

2013

45. Which of the following represents the correct sequence of fundamental decision-making steps in implementing an active IPM program?

(A) Pest Identification → Field Monitoring → Threshold Comparison → Action Implementation → Evaluation
(B) Field Monitoring → Pest Identification → Threshold Comparison → Action Implementation → Evaluation
(C) Action Implementation → Field Monitoring → Pest Identification → Evaluation → Threshold Comparison
(D) Pest Identification → Threshold Comparison → Action Implementation → Field Monitoring → Evaluation

NODIA

2009

46. Setting an action threshold (ETL) unnecessarily low often results directly in:

(A) Increased likelihood of pest eradication.
(B) Enhanced survival and proliferation of natural enemy populations.
(C) Premature and excessive pesticide applications, reducing profitability.
(D) A permanent biological shift in the pest's general equilibrium position.

2011

47. Agronomic manipulations implemented by farmers to create an unfavorable environment for

2024

64. The presence of highly dense trichomes (hairs) on the leaves of a cotton variety, which physically prevents whiteflies from easily reaching the leaf epidermis to feed or oviposit, is an example of:
(A) Tolerance
(B) Biochemical antibiosis
(C) Antixenosis
(D) Induced systemic resistance

2008

65. Consider the following statements regarding Host Plant Resistance (HPR):
I. HPR is highly compatible with biological control agents.
II. Tolerance places intense selection pressure on pest populations to evolve resistance.
III. Antibiosis can lead to the development of novel biotypes in pest populations.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II only
(C) I and III
(D) II and III

2010

66. Implementing a crop variety with extremely high levels of monogenic antibiosis can occasionally lead to an adverse ecological outcome known as:
(A) Increased susceptibility to non-target weed species.
(B) A permanent decrease in the crop's intrinsic photosynthetic capacity.
(C) The immediate extinction of all competing pest species in the ecosystem.
(D) The rapid evolutionary selection of virulent pest biotypes capable of overcoming the resistance.

2024

67. Vertical resistance in host plants is genetically and phenotypically characterized by being:
(A) Controlled by one or a few major genes (monogenic/oligogenic) and being highly specific to certain pest biotypes.
(B) Controlled by many genes (polygenic) and providing partial, long-lasting protection against pathogens.
(C) Uniformly effective against all known species of insect herbivores and pathogens simultaneously in the field.
(D) Strictly dependent on environmental temperature fluctuations to activate its defense mechanisms.

2017

68. Unlike vertical resistance, horizontal resistance in agricultural crop varieties is generally:
(A) Extremely easy to transfer into new varieties using simple backcrossing techniques.
(B) Highly prone to sudden "breakdown" when a new pest biotype emerges.
(C) Polygenically inherited, providing durable, broad-spectrum, but incomplete protection.
(D) Controlled by a single dominant gene that produces an acute toxin.

2021

69. The crystalline endotoxins produced by Bacillus thuringiensis (Bt) and expressed in transgenic insect-resistant crops predominantly target and destroy the insect's:
(A) Midgut epithelial cells
(B) Central nervous system synapses
(C) Respiratory spiracles
(D) Reproductive organs

2008

70. In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:
Assertion (A): The widespread cultivation of Bt-cotton has dramatically reduced the application of broad-spectrum chemical insecticides for bollworm management.
Reason (R): Bt-cotton continuously expresses the Cry toxins which are highly specific and lethal to lepidopteran pests, preempting the need for chemical sprays.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2009

71. Identify the correct statement regarding the integration of transgenic crops into IPM programs:
(A) Transgenic crops eliminate the need for all other IPM tactics, including cultural and biological control.
(B) The high-dose/refuge strategy is a mandatory IRM tactic used to delay pest resistance to Bt crops.
(C) Bt crops are universally toxic to all insect species, including critical pollinators and predators.
(D) Transgenic resistance relies exclusively on

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III. Industrial superheating (heat disinfestation)
IV. Ambient aeration
(A) IV, II, I, III
(B) I, IV, II, III
(C) I, II, IV, III
(D) IV, I, III, II

2011

56. Colored sticky traps (e.g., yellow or blue boards) deployed in field and greenhouse crops are predominantly used for:
(A) Permanently eradicating robust populations of large lepidopteran pests in the field.
(B) Providing a supplemental food source for local parasitoids and other beneficials.
(C) Monitoring population density and mass trapping of small flying insects like aphids and thrips.
(D) Physically altering the microclimate surrounding the crop canopy using reflective light.

2022

57. The use of physical exclusion barriers, such as finely meshed nylon nets, is practically most effective against:
(A) Soil-dwelling nematodes attacking the root system.
(B) Fungal pathogens dispersed via microscopic wind-borne spores.
(C) Endophytic stem borers already present inside the plant tissue.
(D) Small to medium-sized flying insects seeking to oviposit on the crop foliage.

2008

58. Identify the correct pair representing a mechanical pest control method and its associated target mechanism:
(A) Trenching around fields : Preventing the migration of crawling insect pests
(B) Pheromone dispensers : Increasing host-plant susceptibility
(C) Altering planting dates : Enhancing soil fertility
(D) Release of sterile males : Providing alternative prey for birds

2024

59. Which of the following interventions is NOT considered a purely physical or mechanical method of pest control?
(A) Manual hand-picking and destruction of egg masses
(B) Spraying an organophosphate insecticide to induce neural paralysis
(C) Construction of steep-sided trenches to trap migrating armyworms
(D) Application of diatomaceous earth to abrade insect cuticles

2018

60. R.H. Painter's classic triad defining the core mechanisms of Host Plant Resistance (HPR) includes Antixenosis, Antibiosis, and:
(A) Avoidance
(B) Tolerance
(C) Repellency
(D) Immunity

2001

61. In the context of host plant resistance, the mechanism of 'Antixenosis' specifically refers to:
(A) The non-preference of the insect for the plant as a site for oviposition, feeding, or shelter.
(B) The plant's ability to kill the insect via toxic secondary metabolites.
(C) The plant's capacity to regenerate lost tissues rapidly after severe insect feeding.
(D) The genetic modification of the plant to express bacterial endotoxins.

2023

62. A specific crop variety that supports the normal survival, development, and reproduction of a pest but still produces an acceptable economic yield despite the damage is exhibiting:
(A) Antibiosis
(B) Antixenosis
(C) Tolerance
(D) Hypersensitivity

NODIA

2019

63. Identify the INCORRECT statement regarding the 'Antibiosis' mechanism of host plant resistance:
(A) It involves adverse physiological effects on the insect life cycle after feeding on the plant.
(B) It commonly results in increased larval mortality, reduced adult size, and lower fecundity.
(C) It is often mediated by the presence of toxic allelochemicals or an absence of essential nutrients.
(D) It heavily relies on the plant's structural modifications to physically deter the pest from landing.

(B) Pests at low densities stimulate crop plants to produce higher yields.
(C) Low pest populations are necessary to sustain resident natural enemy populations.
(D) Pesticides are generally ineffective against low-density populations.

2024

17. Which of the following statements most accurately reflects a foundational principle of IPM?
(A) Natural enemies should be eradicated to prevent them from damaging the crop.
(B) Chemical interventions should only be applied when pest populations exceed the Action Threshold.
(C) Pest surveillance is only necessary after visible economic damage has occurred.
(D) Crop rotation is largely ineffective and should be replaced by chemical soil fumigation.

2002

18. Which of the following strategies is NOT aligned with the modern IPM paradigm?
(A) Utilizing host plant resistance as a foundational defense.
(B) Enhancing habitat diversity to support conservation biological control.
(C) Employing mechanical barriers and traps to reduce pest influx.
(D) Applying chemical insecticides strictly on a predetermined weekly schedule.

2023

19. The integration of various control tactics in IPM is theoretically designed to:
(A) Create cumulative, multi-faceted mortality pressures that pests cannot easily adapt to.
(B) Ensure mutually antagonistic effects between different control measures.
(C) Maximize the selection pressure for resistance to a single control agent.
(D) Replace the need for routine field scouting and population monitoring.

2003

20. Match the pest forecasting models in List I with their defining characteristics in List II:
List I: (Model Type)
P. Empirical model
Q. Mechanistic model
R. Degree-day model
S. Stochastic model
List II: (Characteristics)
1. Incorporates probability distributions and random environmental variations
2. Relies strictly on accumulated heat units to predict insect developmental stages
3. Uses mathematical equations detailing underlying biological and physiological processes
4. Based on historical statistical correlations and regression analyses
(A) P-4, Q-3, R-2, S-1
(B) P-3, Q-4, R-1, S-2
(C) P-2, Q-1, R-4, S-3
(D) P-1, Q-2, R-3, S-4

2011

21. The sequential sampling technique in pest surveillance is highly advantageous for IPM decision-making because it:
(A) Classifies population levels rapidly without needing a fixed, predetermined sample size.
(B) Requires counting every single insect in the field regardless of density or size.
(C) Focuses solely on identifying the natural enemies present in the local ecosystem.
(D) Eliminates the need to calculate the Economic Threshold Level (ETL) for the crop.

2018

22. In pest forecasting, a synoptic model primarily utilizes which of the following data types to predict widespread pest outbreaks?
(A) Genetic mutation rates of the pest species
(B) Soil microbiome composition
(C) Market price fluctuations of the host crop
(D) Macro-climatic variables and regional weather charts

2001

23. Inaccurate pest surveillance and poorly conducted field scouting most commonly lead to:
(A) Immediate physiological changes in the crop's resistance mechanisms.
(B) Unwarranted chemical applications or failure to intervene when economically justified.
(C) The spontaneous generation of secondary pest species in the soil.
(D) Increased efficacy of biological control agents.

2002

24. Identify the INCORRECT statement regarding pest population sampling techniques:
(A) Absolute sampling methods attempt to estimate the total number of insects per unit area.

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the mechanism of plant tolerance.

2011

72. A major long-term agronomic risk associated with the widespread, unmanaged reliance on monogenic Bt crops is:
(A) The spontaneous conversion of the crop into a weed species.
(B) An immediate and complete collapse of the local soil microbiome.
(C) The rapid selection and proliferation of Bt-resistant pest populations.
(D) The mandatory requirement to double the application of synthetic nitrogen fertilizers.

2005

73. Which of the following resistance classifications is most commonly associated with conferring horizontal resistance?
(A) Monogenic resistance
(B) Oligogenic resistance
(C) Extrachromosomal resistance
(D) Polygenic resistance

2004

74. In the discipline of entomology, the strategy of 'classical biological control' fundamentally involves:
(A) The deliberate introduction and permanent establishment of an exotic natural enemy to control an invasive exotic pest.
(B) The mass rearing and periodic inundative release of native predators to achieve immediate pest knockdown.
(C) Modifying the agro-ecosystem mathematically to enhance the survival of existing natural enemies.
(D) The use of synthetically produced biochemicals that mimic natural enemy kairomones.

2015

75. Consider the following statements concerning biological control agents:
I. Parasitoids typically kill their host slowly and require only one host to complete their development.
II. Predators generally consume multiple prey items throughout their life cycle.
III. Conservation biological control involves the importation of new exotic species.
IV. Inundative release is a form of augmentative biological control.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) II, III and IV
(C) I and II only
(D) I, III and IV

2012

76. In agricultural biological control, a typical insect parasitoid fundamentally differs from an insect predator because the parasitoid:
(A) Is generally much larger than its target host insect.
(B) Develops in or on a single host individual, eventually killing it.
(C) Kills its host immediately upon the very first encounter.
(D) Consumes dozens of prey insects per day during its adult stage.

2015

77. Augmentative biological control, specifically executed through an 'inundative release' strategy, is conceptually most similar to:
(A) The application of a rapid-action chemical insecticide.
(B) A localized quarantine procedure.
(C) A long-term habitat restoration project.
(D) The natural evolutionary process of species mutation.

2007

78. Identify the INCORRECT statement regarding conservation biological control:
(A) It relies on modifying the environment to protect and enhance existing populations of natural enemies.
(B) Practices include reducing pesticide toxicity and establishing nectar-producing floral resources.
(C) It involves the continuous importation of exotic parasitoids from foreign countries.
(D) It aims to improve natural enemy longevity and reproductive success within the agro-ecosystem.

2014

79. The ladybird beetle Cryptolaemus montrouzieri is a specialized predator used extensively in biological control programs primarily to manage:
(A) Rice stem borers
(B) Cotton bollworms
(C) Root-knot nematodes
(D) Mealybugs

2023

80. Match the microbial control agents in List I with their typical mode of action or target group in List II:

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mandatory weekly chemical spray schedules.

2004

127. Degree-day models are standardized mathematical tools widely used in IPM primarily to predict the:
(A) Precise genetic mutation rate of a pest population.
(B) Exact financial market value of the crop at harvest.
(C) Total volume of rainfall expected during the cropping season.
(D) Phenological timing of specific pest life stages, such as egg hash or adult emergence.

2014

128. Mechanistic simulation models designed for understanding pest dynamics fundamentally differ from purely empirical statistical models because mechanistic models:
(A) Disregard all biological realities and rely only on financial data.
(B) Only utilize data collected from entirely artificial greenhouse environments.
(C) Incorporate the underlying biological, physiological, and ecological processes driving population changes.
(D) Cannot be processed using modern computational software.

2016

129. Identify the INCORRECT statement regarding the application of predictive mathematical models in modern IPM:
(A) They can dynamically forecast the optimal timing for biological or chemical interventions.
(B) They completely eliminate the need for any actual field scouting or empirical surveillance by the farmer.
(C) They are highly dependent on the accuracy and resolution of the input meteorological and biological data.
(D) They are foundational components of sophisticated agricultural Decision Support Systems (DSS).

2005

130. In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:
Assertion (A): Systems approach modeling in IPM requires continuous validation with real-world field data.
Reason (R): Agro-ecosystems are complex and highly variable; unvalidated models may produce inaccurate predictions leading to crop loss or excessive chemical use.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

NODIA

2012

131. If a sophisticated stochastic simulation model is utilized to forecast a regional pest outbreak, the final output will represent:
(A) A range of outcomes accompanied by calculated probabilities of occurrence based on environmental variability.
(B) A single, perfectly absolute guarantee of the exact number of insects expected.
(C) A mandate detailing the exact volume of chemical pesticide to be purchased.
(D) The exact genetic sequence of the invading insect biotype.

2019

132. The standard IPM module for managing the rice yellow stem borer (Scirpophaga incertulas) strongly emphasizes the early-season use of:
(A) Prophylactic applications of highly toxic synthetic pyrethroids.
(B) Mass release of sterile adult female moths.
(C) Clipping the tips of rice seedlings prior to transplanting to remove egg masses.
(D) Planting susceptible trap crops completely surrounding the main field.

2021

133. In a cotton IPM module, the strategic installation of vertical bird perches in the field is highly recommended primarily to encourage active predation by avian species on:
(A) Late-instar lepidopteran larvae such as Helicoverpa armigera.
(B) Soil-dwelling root-knot nematodes residing in the root zone.
(C) Microscopic spider mites residing on the underside of leaves.
(D) Fungal spores circulating in the crop canopy during flowering.

2019

134. Identify the correct pair matching a major sugarcane pest with its standard IPM biocontrol intervention:
(A) Sugarcane early shoot borer : Release of

organism.
(C) Evoke an immediate flight or defensive response in individuals of the same species.
(D) Mediate mutualistic interactions where both the emitter and receiver directly benefit.

2007

88. The behavioral control technique known as 'mating disruption' primarily utilizes field-wide permeation with high concentrations of synthetic:
(A) Aggregation pheromones
(B) Host-plant kairomones
(C) Sex pheromones
(D) Alarm pheromones

2023

89. An allomone is a type of allelochemical that provides an adaptive evolutionary advantage primarily to the:
(A) Receiving organism (perceiver)
(B) Symbiotic bacteria within the receiver
(C) Parasitoids searching for the emitter
(D) Emitting organism (producer)

2022

90. Identify the INCORRECT statement regarding the use of semiochemicals in 'mass trapping' strategies:
(A) It is highly successful even against rapidly migrating pest populations from surrounding uncontrolled areas.
(B) It requires a significantly higher density of traps compared to simple population monitoring.
(C) It is most effective when implemented over a large, isolated geographic area.
(D) It often utilizes a combination of sex pheromones and physical sticky or funnel traps.

2003

91. The application of synthetic sex pheromone traps to monitor pest emergence timing is fundamentally aimed at refining the:
(A) Calculation of the crop's intrinsic economic value.
(B) Precision and timing of targeted insecticidal applications.
(C) Accuracy of calculating the General Equilibrium Position (GEP).
(D) Genetic sequencing of the trapped insect population.

2021

92. Synomones differ functionally from other major classes of allelochemicals because they:
(A) Trigger immediate mortality in the receiving organism.
(B) Evoke a behavioral or physiological response that is adaptively favorable to both the emitter and the receiver.
(C) Function exclusively within a single species.
(D) Benefit only the receiving organism, acting as an attractant for predators.

2003

93. The Sterile Insect Technique (SIT) relies fundamentally on the autocidal control concept of:
(A) Mass rearing and releasing millions of competitive, sterile males to mate with wild fertile females.
(B) Releasing sterilized predatory insects to consume wild pest populations.
(C) Applying chemical chemosterilants directly to the crop to sterilize all visiting insects.
(D) Genetically modifying the crop plant to cause sterility in insects that feed on it.

2014

94. The Sterile Insect Technique (SIT) was first conceptualized and successfully employed on a large geographic scale to permanently eradicate the:
(A) Desert locust (Schistocerca gregaria)
(B) Colorado potato beetle (Leptinotarsa decemlineata)
(C) Screwworm fly (Cochliomyia hominivorax)
(D) Cotton boll weevil (Anthonomus grandis)

2006

95. The genetic control strategy known as 'Release of Insects carrying Dominal Lethals' (RIDL) improves upon classical radiation-based SIT primarily by:
(A) Creating insects that live forever but cannot consume plant material.
(B) Ensuring the released insects are highly toxic to natural predators.
(C) Releasing females exclusively to outcompete wild females for oviposition sites.
(D) Utilizing transgenic constructs to induce stage-specific lethality without the debilitating physical effects of massive radiation.

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2017

96. Identify the correct statement regarding 'inherited sterility' (F_1 sterility) as an autocidal control mechanism:
(A) It is exclusively effective against sap-sucking Hemipteran pests.
(B) It requires completely sterilizing the released generation with massive doses of radiation.
(C) It is primarily utilized against Lepidopteran pests, where sub-sterilizing doses produce sterile offspring in the next generation.
(D) It relies on the deliberate introduction of Wolbachia bacteria into the soil.

2015

97. The practical success of a Sterile Insect Technique (SIT) eradication program requires the target wild pest population to initially be:
(A) At its absolute peak epidemic density to ensure maximum mating encounters.
(B) Suppressed to a very low density using prior chemical or cultural control methods.
(C) Genetically resistant to all known chemical insecticides.
(D) Highly polyphagous and widely dispersed across multiple continents simultaneously.

2004

98. Which of the following inherent biological traits makes a pest species POORLY suited for population management via the Sterile Insect Technique (SIT)?
(A) The pest species exhibits a highly restricted geographic range.
(B) The pest can be efficiently and economically mass-reared in an industrial setting.
(C) The released adult stage does not cause severe economic damage to the crop.
(D) The female of the species mates multiple times daily with different males.

2001

99. In modern IPM, 'biorational insecticides' are broadly defined as chemical formulations that:
(A) Are generally highly effective against target pests but possess low toxicity to non-target organisms and the environment.
(B) Contain only highly persistent, bioaccumulative synthetic molecules.
(C) Are derived strictly from petroleum byproducts and have high mammalian toxicity.
(D) Require massive application volumes to be effective.

NODIA

2005

100. In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:
Assertion (A): Insect Growth Regulators (IGRs) are considered excellent components of an IPM program despite their slow speed of kill.
Reason (R): IGRs exhibit high physiological selectivity, disrupting specific insect developmental processes like molting, while relatively harmless to adult natural enemies and vertebrates.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019

101. Azadirachtin, extracted from the seeds of the neem tree, exerts its primary physiological effect on insects fundamentally as an:
(A) Antifeedant and insect growth disruptor (ecdysone antagonist).
(B) Immediate neurotoxic paralyzing agent.
(C) Abrasive desiccant that strips the cuticular wax layer.
(D) Inhibitor of cellular respiration in the mitochondria.

2023

102. Chitin synthesis inhibitors, a class of Insect Growth Regulators (IGRs), are practically most effective when applied to insects during the:
(A) Adult reproductive stage, preventing mating.
(B) Egg stage, causing immediate chorion hardening.
(C) Pupal diapause stage, preventing metabolic slowdown.
(D) Immature larval or nymphal stages, specifically prior to molting.

2018

103. Identify the INCORRECT statement regarding the application and biology of Insect Growth Regulators (IGRs):
(A) They often require precise timing of application targeting susceptible developmental windows.
(B) They cause immediate "knock-down" mortality within minutes of application.
(C) They are structurally mimics or antagonists of key insect hormones like ecdysone or juvenile hormone.

(D) They generally exhibit a favorable environmental profile and low mammalian toxicity.

2021

104. Juvenile hormone analogues (JHAs) synthetically applied to late-instar insect larvae typically result directly in:
(A) Instantaneous paralysis of the gut muscles.
(B) Accelerated metamorphosis resulting in precocious, miniature adults.
(C) The formation of lethal larval-pupal intermediates or supernumerary larval instars.
(D) The production of sterile adult males only.

2023

105. Spinosad is widely classified as a highly effective biorational insecticide primarily because it is derived from:
(A) The extracted essential oils of the chrysanthemum flower.
(B) A synthetic organophosphate formulation engineered for rapid degradation.
(C) The crushed exoskeletons of marine crustaceans.
(D) The fermentation process of the soil actinomycete Saccharopolyspora spinosa.

2012

106. In chemical pest management, 'ecological selectivity' of a broad-spectrum insecticide is practically achieved primarily through:
(A) Manipulating the timing, placement, or formulation of the application to avoid natural enemies.
(B) The inherent biochemical pathway targeted by the active ingredient in the pest.
(C) Engineering the chemical to exclusively bind to Lepidopteran receptors in larvae.
(D) Mixing the insecticide with a high-concentration botanical oil for better spread.

2019

107. The concept of 'physiological selectivity' in a pesticide refers specifically to its inherent ability to:
(A) Evaporate rapidly from the leaf surface before natural enemies arrive.
(B) Be inherently more toxic to the target pest species than to non-target natural enemies due to differences in metabolism or target-site physiology.
(C) Be applied specifically to the roots rather than the foliage.
(D) Alter the physical growth rate of the host crop to outgrow pest damage.

2002

108. The scientific framework of Insecticide Resistance Management (IRM) primarily advocates for:
(A) Applying sub-lethal doses of chemicals to allow insects to build immunity safely.
(B) Rotating insecticides with distinctly different modes of action (MoA) to reduce consistent selection pressure.
(C) Mixing multiple highly toxic organophosphates in a single tank to overwhelm the pests.
(D) Exclusively using a single highly effective chemical mode of action until it completely fails.

2006

109. The phenomenon of 'cross-resistance' typically occurs when an insect population:
(A) Develops a specific physiological resistance mechanism that coincidentally confers resistance to other, unexposed insecticides sharing a similar mode of action.
(B) Becomes simultaneously resistant to both biological control agents and physical trapping methods.
(C) Migrates across geographic borders to mate with completely susceptible populations.
(D) Loses its previously acquired resistance due to a lack of chemical exposure over many generations.

2004

110. Match the insecticide terminology in List I with its accurate definition in List II:
List I: (Term)
P. Synergism
Q. Antagonism
R. Cross-resistance
S. Multiple resistance
List II: (Definition)
1. Resistance to multiple distinct insecticide classes through separate co-existing resistance mechanisms
2. Resistance to multiple chemicals sharing a single common metabolic detoxification pathway
3. Toxicity of a chemical mixture is significantly greater than the sum of their individual toxicities
4. Toxicity of a chemical mixture is significantly less than the effect of the most toxic component alone

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List I: (Control Agent)
P. Bacillus thuringiensis (Bt)
Q. Beauveria bassiana
R. Nuclear Polyhedrosis Virus (NPV)
S. Steinernema spp.
List II: (Mechanism/Target)
1. Infects primarily via ingestion and targets the midgut with Cry proteins
2. Highly specific virus that causes larval liquefaction, primarily in Lepidoptera
3. Entomopathogenic nematode that releases mutualistic lethal bacteria into the insect hemocoel
4. Entomopathogenic fungus that invades directly through the insect cuticle
(A) P-1, Q-4, R-2, S-3
(B) P-4, Q-1, R-3, S-2
(C) P-2, Q-3, R-1, S-4
(D) P-1, Q-2, R-4, S-3

2010

81. Unlike many other entomopathogens, entomopathogenic fungi such as Metarhizium anisopliae primarily infect insect hosts through:
(A) Ingestion of contaminated plant foliage.
(B) Direct penetration and colonization through the external cuticle/integument.
(C) Transmission via specialized sucking insect vectors.
(D) Entry exclusively through the respiratory spiracles.

2002

82. Formulations of Nuclear Polyhedrosis Viruses (NPVs) are most highly effective and routinely utilized against agricultural pests belonging to the order:
(A) Coleoptera
(B) Hemiptera
(C) Orthoptera
(D) Lepidoptera

2010

83. Entomopathogenic nematodes (EPNs) achieve high insect mortality rapidly due to their obligate mutualistic relationship with lethal bacteria of the genera:
(A) Xenorhabdus and Photorhabdus
(B) Agrobacterium and Rhizobium
(C) Pseudomonas and Bacillus
(D) Escherichia and Salmonella

2009

84. Identify the correct statement regarding the field utilization of Bacillus thuringiensis (Bt) commercial formulations:
(A) They provide excellent control against all piercing-sucking insect pests in vegetables.
(B) They possess systemic activity and move actively through the plant's vascular tissue.
(C) They exhibit high target specificity and generally have minimal impact on beneficial natural enemies.
(D) They remain stable and highly active on crop foliage for several months after a single application.

2024

85. Consider the following statements regarding microbial control agents:
I. Sunlight (UV radiation) rapidly degrades field-applied NPV formulations.
II. Entomopathogenic fungi require high ambient humidity for successful spore germination.
III. Bt requires an acidic midgut environment to dissolve its toxic crystals.
IV. Entomopathogenic nematodes are highly effective against foliar pests in dry environments.
V. Microbial agents generally exhibit a longer shelf-life than synthetic chemical insecticides.
Which of the above statement(s) is/are INCORRECT?
(A) I, II and III
(B) III, IV and V
(C) II, III and IV
(D) I, IV and V

2016

86. Which specific environmental factor is generally considered the MOST detrimental to the persistence and field efficacy of unformulated, sprayed Nuclear Polyhedrosis Viruses (NPVs)?
(A) High atmospheric carbon dioxide levels
(B) Heavy soil compaction
(C) Moderate ambient field humidity
(D) Intense solar ultraviolet (UV) radiation

2003

87. In the classification of semiochemicals, 'kairomones' are interspecific chemical messengers that:
(A) Benefit the emitter organism but harm the receiver organism.
(B) Benefit the receiving organism while being adaptively disadvantageous to the emitting

NODIA

(A) Increased efficiency of chemical pesticide applications.
(B) Disrupted pest host-finding behaviors and enhanced natural enemy activity.
(C) The complete absence of host-specific olfactory cues.
(D) The permanent elimination of the pest's reproductive organs.

2006

120. Conservation agriculture practices, such as zero or minimum tillage, predominantly influence pest and natural enemy dynamics by:
(A) Completely sterilizing the upper soil profile of all biological activity.
(B) Decreasing the available soil moisture required for plant growth.
(C) Preserving soil structure and crop residues, which enhances populations of epigeal predators like carabid beetles.
(D) Increasing the daily maximum temperature of the topsoil layer.

2019

121. Identify the correct statement regarding the use of mulching in conservation agriculture from a pest management perspective:
(A) Synthetic plastic mulches are primarily used to encourage weed growth as alternative hosts.
(B) Mulching effectively increases the splashing of soil-borne pathogens onto the crop foliage.
(C) Organic mulches invariably lead to a complete eradication of soil-dwelling pests.
(D) Organic mulches provide favorable microhabitats that can significantly increase the abundance of generalist ground predators.

2021

122. Which of the following continuous cropping practices usually INCREASES the localized proliferation and spread of soil-borne pests and nematodes?
(A) Successive monocropping of the same highly susceptible host plant
(B) Long-term crop rotation with non-host species
(C) Deep summer ploughing and solarization
(D) Flooding the field for extended periods

2007

123. The successful 'push-pull' technology developed for farming systems relies fundamentally on the strategic spatial use of:
(A) Synthetic sex pheromones (push) and heavy chemical spraying (pull).
(B) Repellent intercrops (push) and highly attractive trap crops (pull).
(C) Mechanical barriers (push) and vacuum extractors (pull).
(D) Sterile male insects (push) and biological pathogens (pull).

2018

124. Extensive, unbroken agricultural monoculture often removes natural physical and ecological barriers to insect movement, directly leading to:
(A) The immediate starvation of specialized pest species.
(B) The rapid, unimpeded spatial dispersal and exponential growth of pest populations.
(C) A rapid decrease in the pest's general equilibrium position.
(D) The spontaneous creation of new, highly aggressive parasitoid species.

2009

125. Consider the following statements regarding predictive mathematical models in IPM:
I. Mechanistic models simulate biological processes like development and mortality.
II. Degree-day models require accurate localized temperature data to be predictive.
III. Empirical models are universally applicable to any geographic region without local calibration.
IV. Simulation models can help evaluate the potential long-term outcomes of different management tactics.
Which of the above statement(s) is/are INCORRECT?
(A) III only
(B) I and II
(C) II and IV
(D) I, II and III

2009

126. In the structured context of Integrated Pest Management, a Decision Support System (DSS) is best defined as:
(A) A legislative body responsible for banning highly toxic pesticides.
(B) A physical mechanical device used to sort infested seeds from healthy seeds.
(C) An interactive, computer-based tool integrating data, models, and knowledge to assist farmers in making optimal pest choices.
(D) A rigid, unchangeable calendar outlining

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(B) Sweet corn
(C) Basil
(D) Spinach

2005

142. In the intensive cultivation of cruciferous crops (e.g., cabbage), Indian mustard is planted as a peripheral trap crop primarily to attract and concentrate:
(A) The cabbage root maggot
(B) Pathogenic soil nematodes
(C) The Diamondback Moth (DBM) and aphids
(D) Beneficial honeybees exclusively

2012

143. A well-timed, properly formulated foliar spray of Neem Seed Kernel Extract (NSKE) applied in crucifer IPM is primarily intended to function biochemically as an:
(A) Immediate contact neurotoxin.
(B) Aggregation pheromone to draw pests into a single area.
(C) Herbicide to eliminate competing weed species.
(D) Antifeedant and potent oviposition deterrent.

2023

144. The landmark IPM success story regarding the management of the Brown Planthopper (BPH) in Asian rice systems primarily involved:
(A) The universal introduction of a single highly toxic organophosphate chemical to the region.
(B) The mass global release of millions of sterile BPH males to outcompete native wild males.
(C) Minimizing disruptive insecticide use to conserve natural spider and bug predators.
(D) Completely halting the cultivation of rice for several years to break the insect life cycle.

2021

145. Which of the following represents the correct sequence of historical events that typically necessitate the formulation of a comprehensive IPM program?
(A) Prophylactic spraying → Destruction of natural enemies → Pest resurgence/ Resistance → Crisis phase → Implementation of IPM
(B) Crisis phase → Pest resurgence → Prophylactic spraying → Implementation of IPM → Destruction of natural enemies
(C) Implementation of IPM → Crisis phase → Prophylactic spraying → Pest resurgence → Destruction of natural enemies
(D) Pest resurgence → Implementation of IPM → Prophylactic spraying → Crisis phase → Destruction of natural enemies

2019

146. The widespread failure of cotton cultivation across multiple regions during the late 1990s was largely precipitated by the development of extreme, multi-chemical resistance in which specific pest complex?
(A) The cotton aphid and whitefly complex
(B) The cotton stainer bug complex
(C) The soil-borne nematode complex
(D) The cotton bollworm complex (primarily Helicoverpa armigera)

2013

147. The management paradigm for the Diamondback Moth (DBM) globally shifted toward IPM, integrating Bacillus thuringiensis and parasitoids, primarily because the pest:
(A) Developed extreme, rapid resistance to almost every available class of synthetic chemical insecticide.
(B) Was completely eradicated by chemical means in most countries through intensive regional spraying.
(C) Mysteriously shifted its host preference from crucifers to legumes in tropical climates.
(D) Was heavily predated upon by migrating avian species during the spring season.

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2010

148. Identify the correct statement regarding the successful IPM program implemented for the cotton bollworm complex in India prior to the advent of Bt-cotton:
(A) It relied exclusively on the manual hand-picking of adult moths.
(B) It legally mandated the continuous use of synthetic pyrethroids throughout the season.
(C) It heavily emphasized routine scouting, economic thresholds, IRM strategies, and the use of HaNPV.
(D) It banned the use of any biological control agents to prevent competition with chemicals.

2003

149. The catastrophic ecological resurgence of the rice brown planthopper (BPH) in the 1970s and 1980s was scientifically linked to:
(A) The insecticide-induced mortality of highly effective natural predators, particularly lycosid spiders.

Epiricania melanoleuca
(B) Sugarcane internode borer : Application of high-dose nitrogen fertilizers
(C) Sugarcane root borer : Spraying of synthetic pyrethroids
(D) Sugarcane pyrilla : Conservation and redistribution of Epiricania melanoleuca

2004

135. Consider the following statements regarding standard IPM modules for major field crops:
I. In rice IPM, excessive nitrogen application is avoided to prevent Brown Planthopper (BPH) resurgence.
II. In cotton IPM, deep summer ploughing exposes overwintering bollworm pupae to desiccation and predation.
III. In pulse IPM, pheromone traps are widely deployed to monitor Helicoverpa armigera populations.
IV. In sugarcane IPM, the burning of trash is strictly recommended to increase borer survival.
V. In cotton IPM, the use of refugia is mandatory when planting Bt varieties.
Which of the above statement(s) is/are correct?
(A) I, II, III and V
(B) I, II, IV and V
(C) II, III, IV and V
(D) I, III, IV and V

2003

136. In the cultivation of pulse crops (e.g., chickpea, pigeonpea), deep summer ploughing is a highly recommended cultural IPM tactic primarily intended to destroy the:
(A) Airborne fungal spores of rust diseases.
(B) Active adult moths feeding on floral nectar.
(C) Diapausing pupae of Helicoverpa armigera resting in the soil profile.
(D) Egg masses laid directly on the vegetative crop canopy.

2004

137. Which of the following specific interventions is NOT typically included as a recommended tactic within the IPM module for managing the chickpea pod borer (Helicoverpa armigera)?
(A) Erection of bird perches to facilitate predation by insectivorous birds.
(B) Application of HaNPV (Nuclear Polyhedrosis Virus) during early larval instars.
(C) Intercropping chickpea with coriander or mustard to attract beneficial parasitoids.
(D) Routine application of broad-spectrum organochlorine insecticides during the vegetative stage.

2012

138. In the formulated IPM module for mango cultivation, the physical application of slippery or sticky bands around the main tree trunks specifically targets the management of:
(A) Mango mealybug nymphs crawling up the trunk from the soil.
(B) Mango hoppers migrating from the inflorescence to the leaves.
(C) Mango fruit flies ovipositing directly into the ripening fruit.
(D) Mango nut weevils emerging from the fallen seeds.

2022

139. Identify the INCORRECT statement regarding the standard IPM management of the citrus leaf miner:
(A) Management primarily relies on the protection of new vegetative flushes.
(B) Heavy, prophylactic applications of synthetic pyrethroids are recommended to eradicate the pest.
(C) Sprays of Neem Seed Kernel Extract (NSKE) act as an effective oviposition deterrent.
(D) Conserving native eulophid parasitoids is a crucial biological control component.

2012

140. Match the horticultural crop in List I with its specific trap crop strategy in List II:
List I: (Main Crop)
P. Tomato (for Helicoverpa)
Q. Cabbage (for DBM)
R. Cotton (for Earias spp.)
S. Groundnut (for Spodoptera)
List II: (Trap Crop)
1. Okra
2. Castor
3. Marigold
4. Mustard
(A) P-1, Q-4, R-2, S-3
(B) P-4, Q-1, R-3, S-2
(C) P-2, Q-3, R-1, S-4
(D) P-3, Q-4, R-1, S-2

NODIA

2005

141. The standard IPM module for managing the tomato fruit borer (Helicoverpa armigera) relies on the strategic use of which specific trap crop to divert oviposition?
(A) Marigold

(A) P-4, Q-3, R-1, S-2
(B) P-3, Q-4, R-2, S-1
(C) P-2, Q-1, R-4, S-3
(D) P-1, Q-2, R-3, S-4

2002

111. Tank mixing two distinct pesticides that undergo a direct chemical reaction in the vat, resulting in heavy precipitation and clogged sprayer nozzles, is an example of:
(A) Physiological antagonism
(B) Biological synergism
(C) Ecological selectivity
(D) Physical/Chemical incompatibility

2003

112. In agro-ecosystem dynamics, the "enemies hypothesis" suggests that increased plant diversity within an agricultural field:
(A) Increases the toxicity of naturally occurring botanical compounds.
(B) Confuses the natural enemies, rendering them less effective.
(C) Enhances natural enemy abundance and effectiveness by providing alternative prey, nectar, and stable microhabitats.
(D) Promotes severe competitive exclusion among predator species.

2013

113. A highly robust, complex food-web structure within an agro-ecosystem generally leads to a biological state where pest populations remain near their:
(A) Absolute maximum biological carrying capacity.
(B) General Equilibrium Position (GEP) well below the Economic Injury Level.
(C) Rapid exponential growth phase indefinitely.
(D) Damage Boundary continuously throughout the season.

2014

114. Identify the INCORRECT statement regarding the ecological role of natural enemy reservoirs:
(A) They are designated non-crop habitats that provide refuge for beneficial insects during adverse conditions.
(B) They can include hedgerows, uncultivated field margins, or adjacent forest patches.
(C) They supply critical overwintering sites for parasitoids and predatory arthropods.
(D) They actively contribute to the rapid evolutionary development of insecticide resistance in pests.

2009

115. Consider the following statements regarding biodiversity and pest regulation in agro-ecosystems:
I. Monocultures typically lack the diverse microhabitats required to sustain robust natural enemy populations.
II. Increased biodiversity always guarantees the absolute elimination of all key pests.
III. Polyphagous predators benefit significantly from the spatial heterogeneity provided by mixed cropping.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) III only

2004

116. Providing specifically selected floral resources on agricultural field margins is an ecological tactic aimed primarily at enhancing the:
(A) Soil organic carbon concentration.
(B) Nutritional value of the primary harvested crop.
(C) Lifespan, fecundity, and searching efficiency of adult parasitoid wasps.
(D) Visual appeal of the agro-ecosystem to large mammalian herbivores.

2025

117. In the context of ecological food-web interactions, the 'top-down' regulation of pest populations refers explicitly to the control exerted by:
(A) Predators, parasitoids, and entomopathogens consuming the herbivores.
(B) The intrinsic nutritional quality and defensive compounds of the host plant.
(C) Large-scale meteorological events like heavy rainfall and freezing temperatures.
(D) Chemical applications applied from aerial spraying equipment.

2011

118. The 'resource concentration hypothesis' ecologically explains why pest outbreaks are generally much more frequent and severe in:
(A) Complex polyculture systems
(B) Undisturbed primary forests
(C) Highly fragmented landscapes
(D) Extensive monoculture systems

2014

119. Compared to expansive monocultures, polycultures typically experience significantly reduced pest herbivory due to:

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(B) A sudden, unprecedented global increase in atmospheric temperatures during the monsoons.
(C) The unintentional introduction of a highly aggressive, exotic hyperparasitoid to the area.
(D) The widespread adoption of organic farming practices in Southeast Asian rice ecosystems.

2011

150. In the context of socio-economic and practical constraints hindering farmer-level IPM adoption, an "institutional constraint" most accurately refers to:
(A) The inherent biological complexity of the pest's life cycle.
(B) The high cost of labor required for mechanical harvesting.
(C) The genetic instability of locally bred crop varieties.
(D) The lack of extension services, organized training, and quality-controlled biological inputs.

2010

151. Which of the following specific socio-economic factors most consistently impedes the widespread adoption of knowledge-intensive IPM practices by marginal and smallholder farmers?
(A) The guaranteed higher market price they instantly receive for IPM-grown produce.
(B) High initial cost and lack of availability of biological agents compared to cheap, subsidized chemical pesticides.
(C) A fundamental lack of trust in synthetic chemical fertilizers applied to the field.
(D) The extreme simplicity and absolute lack of required training for IPM methods.

2012

152. Identify the INCORRECT statement regarding the technological constraints currently limiting the implementation of IPM:
(A) Quality control and standard formulation of biopesticides are often poor or highly variable in developing markets.
(B) Biological control agents frequently suffer from extremely short shelf-lives compared to synthetic chemicals.
(C) Sophisticated mathematical forecasting models often lack the necessary localized meteorological data to be accurate.
(D) Synthetic broad-spectrum pesticides are generally much harder to physically apply to a field than complex biological agents.

2022

153. The comparatively high initial knowledge requirement and the learning curve required for a farmer to accurately identify pests, scout fields, and calculate thresholds is formally considered a:
(A) Purely legislative constraint to IPM adoption.
(B) Biological advantage of IPM implementation.
(C) Mandatory prerequisite for purchasing chemical fertilizers.
(D) Cognitive and educational constraint to IPM adoption.

2025

154. Farmers operating in risk-averse environments often exhibit a preference for applying broad-spectrum chemical pesticides over implementing nuanced IPM strategies because chemical pesticides generally provide:
(A) Highly visible, rapid, and predictable immediate mortality of the pest population.
(B) A permanent increase in soil fertility and nutrient availability in the field.
(C) Long-term enhancement of the local natural enemy community and habitat.
(D) Absolute immunity from future regulatory scrutiny by agricultural officials.

2025

155. Arrange the following plant quarantine and policy implementation phases in their correct chronological procedural order:
I. Pest Risk Analysis (PRA) of the imported agricultural commodity
II. Issuance of a Phytosanitary Certificate by the exporting country
III. Inspection and potential fumigation at the designated Port of Entry
IV. Domestic post-entry quarantine observation
(A) II, I, IV, III
(B) I, III, II, IV
(C) I, II, III, IV
(D) III, II, IV, I

2004

156. National and international plant quarantine regulations fundamentally function as a critical preventative IPM strategy designed to:
(A) Maximize the volume of agricultural chemical exports.
(B) Legally restrict movement of commodities to prevent the introduction and spread of exotic pests.
(C) Genetically modify all imported seeds before they are planted.

NODIA

to economics, the ETL specifically incorporates the time for treatment efficacy.

43. (B) Field scouting and pest population monitoring
Successfully utilizing the Economic Threshold Level for management decisions fundamentally depends on continuous and accurate field scouting and pest population monitoring. Without real-time data on pest numbers and their rate of increase, it is impossible to determine when the threshold has been reached. Regular surveillance allows for precise timing of interventions, reducing unnecessary chemical use and protecting overall crop yield.

44. (D) The global historical evolutionary origin of the pest species.
Factors such as crop market price, physiological growth stage, and the abundance of natural enemies are used to dynamically adjust the Economic Threshold Level during the growing season. However, the global historical evolutionary origin of a pest species is irrelevant to real-time management decisions in the field. Decision-making focuses on current economic and ecological variables that directly influence profitability.

45. (A) Pest Identification → Field Monitoring → Threshold Comparison → Action Implementation → Evaluation
Implementing an active Integrated Pest Management program follows a logical sequence. First, the pest must be accurately identified. This is followed by consistent field monitoring to assess population density. These findings are then compared against established thresholds to decide if action is necessary. Finally, the intervention is implemented, and its effectiveness is evaluated to inform future management decisions.

46. (C) Premature and excessive pesticide applications, reducing profitability.
Setting an action threshold unnecessarily low often leads directly to premature and excessive pesticide applications. This practice increases production costs and reduces overall farm profitability without providing significant yield benefits. Furthermore, it can cause secondary ecological issues, such as the destruction of beneficial natural enemies and the acceleration of insecticide resistance development within the target pest population.

47. (D) Cultural control
Cultural control refers to the use of purposeful agronomic manipulations by farmers to create an environment that is unfavorable for the development, survival, and reproduction of pests. These practices, which include crop rotation, sanitation, and adjustments to planting dates, aim to minimize pest pressure through standard farming activities. They are foundational, low-cost components of any comprehensive Integrated Pest Management program.

48. (C) Offering a highly preferred alternative host to draw pests away from the main crop.
Trap cropping is an ecological strategy that involves planting a highly preferred alternative host species alongside the main crop. The goal is to draw pests away from the primary crop and concentrate them in a smaller, restricted area. Once concentrated on the trap crop, the pests can be more easily managed or destroyed, thereby reducing the infestation on the main crop.

49. (B) Inducing asynchrony between the susceptible stage of the crop and the peak emergence of the pest.
Altering sowing dates is a cultural control tactic that manages pest populations by inducing asynchrony between the most susceptible stage of the crop and the peak emergence period of the pest. By shifting the timing of planting, the crop may avoid heavy infestation during critical growth phases, thereby reducing the need for chemical interventions and minimizing potential yield loss.

50. (A) P-3, Q-1, R-2, S-4
Different cultural control tactics employ distinct mechanisms to suppress pests. Crop rotation disrupts food supply continuity for specialized pests, while field sanitation removes critical overwintering sites. High seeding rates help compensate for early-season damage, and trap cropping concentrates populations for easier destruction. These agronomic practices are integrated to provide a multi-faceted defense against insect infestations within sustainable agricultural systems.

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ANSWERS

1. (B) Its General Equilibrium Position (GEP) lies consistently above the Economic Injury Level (EIL).
Key pests are permanent residents of an agro-ecosystem that consistently cause economic damage because their average population density remains above the Economic Injury Level. These organisms require regular and proactive management strategies since their natural mortality factors are insufficient to maintain their numbers below thresholds that trigger financial loss. This classification helps farmers prioritize long-term suppression efforts.

2. (D) Occasional pests
Occasional pests are characterized by a long-term average population density that normally stays well below the Economic Injury Level. However, under specific and unusually favorable environmental conditions, their numbers can rapidly increase and cross the damage threshold. Because these outbreaks are infrequent and tied to transient factors, management is typically reactive and limited to periods of actual infestation.

3. (A) Exhibit sudden, severe, and widespread population explosions across large areas.
Epidemic pests exhibit dramatic and widespread population surges that occur over large geographic regions. These outbreaks are usually triggered by exceptionally conducive weather patterns or sudden migrations. Unlike endemic or regular pests, these organisms cause severe, catastrophic damage intermittently rather than annually. Controlling such pests often requires coordinated regional surveillance and large-scale intervention strategies to mitigate extensive agricultural losses.

4. (C) They consistently migrate across continental borders during their adult stage.
Endemic pests are localized organisms found consistently within a specific geographic area or region year after year. Their presence and abundance are closely linked to stable local factors like soil type, microclimate, and host availability. They generally cause steady, predictable damage. Unlike migratory pests, they do not typically undertake massive, long-distance movements across continental borders as a defining characteristic.

NODIA

5. (A) Sub-economic pest
A sub-economic pest is an organism that is frequently present in the field but whose population density remains functionally below the Economic Threshold Level. While these insects may consume crop tissues, the cost of implementing control measures would exceed the value of the potential yield loss saved. They are considered minor components of the ecosystem requiring no active chemical intervention.

6. (D) They are absent from the ecosystem until introduced by extreme weather events.
Regular pests occur frequently and predictably within an agro-ecosystem due to their strong association with specific host crops. They are not intermittent visitors introduced by weather events but are persistent residents. Farmers can anticipate their arrival during specific crop growth stages, allowing for routine monitoring and established management protocols to keep their populations below levels that cause significant economic damage.

7. (B) The unilateral reliance on synthetic broad-spectrum insecticides.
The shift toward Integrated Pest Management was driven by the catastrophic failure of the unilateral pesticide-heavy approach. Over-reliance on broad-spectrum synthetic chemicals led to severe environmental degradation, human health risks, and ecological disruptions. These issues highlighted the need for a more holistic strategy that utilizes diverse biological and cultural tactics while minimizing chemical inputs to ensure long-term agricultural sustainability.

8. (C) Pest resistance, resurgence, and secondary pest outbreaks.
The late pesticide era was defined by a systemic failure where pests developed widespread genetic resistance to chemical treatments. Furthermore, the elimination of natural enemies caused pest resurgence and the emergence of secondary pests that were previously insignificant. This

(D) Eradicate all native, endemic pest species currently residing within the country.

2017

157. The participatory 'Farmer Field School' (FFS) extension methodology, designed to promote IPM adoption through experiential learning, was originally pioneered primarily in response to pest crises in:
(A) Asian irrigated rice ecosystems.
(B) North American intensive wheat monocultures.
(C) European greenhouse tomato production.
(D) African extensive agroforestry systems.

2015

158. At the national level, the formulation and strict enforcement of a robust phytosanitary policy relies primarily on the continuous execution of:
(A) Unregulated free-market agricultural trade.
(B) Blanket bans on all international agricultural imports regardless of origin.
(C) Scientifically rigorous Pest Risk Analysis (PRA) and continuous surveillance.
(D) Subsidizing the domestic manufacture of highly toxic organophosphates.

2013

159. Identify the correct statement regarding international IPM and phytosanitary policy frameworks:
(A) The WTO SPS Agreement prohibits countries from setting their own health standards.
(B) International quarantine laws actively encourage the transboundary movement of known biological control pathogens without restriction.
(C) The implementation of strict quarantine eliminates the need for any domestic IPM programs.
(D) The International Plant Protection Convention (IPPC) sets globally recognized standards to prevent the spread of plant pests.

2019

160. The primary legislative backing and statutory authority for the enforcement of domestic and international plant quarantine regulations in India is derived from the:
(A) Insecticides Act, 1968
(B) Environment Protection Act, 1986
(C) Destructive Insects and Pests (DIP) Act, 1914
(D) Biological Diversity Act, 2002

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17. (B) Chemical interventions should only be applied when pest populations exceed the Action Threshold.
A foundational principle of Integrated Pest Management is that chemical interventions should be reserved as a last resort. They are only applied when field monitoring indicates that a pest population has exceeded a specific Action Threshold or Economic Threshold. This data-driven approach prevents unnecessary pesticide use, reduces environmental contamination, and helps delay the development of insecticide resistance in target populations.

18. (D) Applying chemical insecticides strictly on a predetermined weekly schedule.
Applying chemical insecticides on a predetermined weekly schedule is contrary to the Integrated Pest Management paradigm, which emphasizes data-driven decision-making. IPM relies on field scouting and economic thresholds to determine if and when treatments are necessary. Scheduled spraying ignores actual pest densities, leading to excessive chemical use, destruction of natural enemies, and accelerated development of resistance within the insect.

19. (A) Create cumulative, multi-faceted mortality pressures that pests cannot easily adapt to.
The integration of diverse control tactics in Integrated Pest Management is designed to impose cumulative and multi-faceted mortality pressures on pest populations. By combining biological, cultural, mechanical, and chemical methods, the system makes it significantly more difficult for pests to adapt or develop resistance compared to a single-tactic approach. This strategy ensures robust, long-term suppression and enhances overall stability.

20. (A) P-4, Q-3, R-2, S-1
Pest forecasting involves various mathematical approaches. Empirical models use historical statistical correlations, while mechanistic models simulate underlying physiological processes. Degree-day models track accumulated heat units to estimate developmental timing, and stochastic models incorporate random environmental variations and probability. Together, these tools allow for precise agricultural planning and help determine the most effective timing for necessary pest management interventions in fields.

21. (A) Classifies population levels rapidly without needing a fixed, predetermined sample size.
Sequential sampling is a highly efficient technique for Integrated Pest Management decision-making because it allows for rapid classification of pest population levels. Unlike fixed-sample methods, the total number of samples taken depends on the density observed during the process. This approach minimizes field scouting time and labor costs by allowing for a quick treat or no-treat decision during surveillance.

22. (D) Macro-climatic variables and regional weather charts.
Synoptic models in pest forecasting primarily utilize macro-climatic data and regional weather charts to predict the large-scale movement and outbreaks of highly mobile pests. By analyzing wind patterns, temperature gradients, and moisture levels, these models can anticipate the arrival of migratory insects like locusts. This enables regional authorities and farmers to prepare for potential infestations before they arrive.

NODIA

23. (B) Unwarranted chemical applications or failure to intervene when economically justified.
Inaccurate pest surveillance and poor field scouting lead to critical management errors, such as making unwarranted chemical applications when pests are below thresholds or failing to intervene when damage is economically justified. Both outcomes decrease farming profitability and ecological health. Reliable data is essential for the success of any Integrated Pest Management program, ensuring that interventions are timely and necessary.

24. (C) Light traps provide an exact absolute estimate of the localized larval population in the soil.
Light traps are relative sampling tools used primarily to monitor the activity and seasonal flight patterns of adult nocturnal insects. They do not provide an exact absolute estimate of localized larval populations residing in the soil. Absolute sampling requires direct counts per unit area, whereas relative methods offer comparative data regarding population trends over time and space for management decisions.

25. (B) II and III
In pest monitoring, systematic sampling involves inspecting plants at fixed intervals rather than

every single plant in a field. Additionally, action thresholds are dynamic and change based on the crop's physiological growth stage, market value, and the presence of natural enemies. Understanding these nuances is vital, as rigid or excessive monitoring can lead to inefficient resource allocation and poor decisions.

26. (A) Obtain highly accurate population density estimates for academic research or modeling.
Fixed-precision sampling plans are primarily utilized when highly accurate estimates of pest population density are required for academic research or complex ecological modeling. Unlike decision-based sampling, which focuses on threshold boundaries, fixed-precision methods ensure that the level of sampling error remains within a specific, predetermined range. This provides the robust data necessary for understanding long-term population dynamics and distributions.

27. (B) The average long-term pest density over time without permanent environment changes.
The General Equilibrium Position represents the average population density of a species over a long period within a stable environment. It is the level around which the population fluctuates due to the influence of temporary environmental factors. In pest management, the relationship between the General Equilibrium Position and the Economic Injury Level determines the ecological classification of an insect species.

28. (B) Measurable crop injury begins to translate into measurable yield loss.
The Damage Boundary is the specific pest population density at which measurable plant injury begins to result in a statistically significant loss in crop yield. It represents the lowest level of injury that can be detected and linked to economic impact. This conceptual point is situated below the Economic Injury Level and serves as the biological foundation for developing thresholds.

29. (A) The Damage Boundary indicates the onset of yield loss, whereas the ETL indicates when management action must be taken to prevent reaching the EIL.
The Damage Boundary marks the biological onset of yield loss caused by pest injury, whereas the Economic Threshold Level is a management decision point. The ETL is set at a density lower than the Economic Injury Level to provide enough time for control measures to take effect. While the Damage Boundary relates to plant response, the ETL incorporates time and logistics.

30. (C) An introduction of a highly effective, permanent classical biocontrol agent will permanently lower a pest's GEP.
The introduction of a highly effective and permanent classical biological control agent can permanently lower the General Equilibrium Position of a pest population. By establishing a new, consistent mortality factor in the environment, the average density of the pest is reduced over the long term. This ecological shift can successfully downgrade a key pest to a sub-economic or occasional status.

31. (D) Consistently below the Economic Injury Level (EIL) and rarely reaching the Damage Boundary.
For an insect to be classified as a sub-economic pest, its General Equilibrium Position must reside consistently below the Economic Injury Level. These populations rarely reach the Damage Boundary, meaning the injury they cause is negligible and does not justify the cost of control. Management for such pests is generally unnecessary as they do not threaten financial viability.

32. (C) A single, localized application of a short-lived botanical insecticide.
A single, localized application of a short-lived insecticide is unlikely to permanently influence the General Equilibrium Position of a pest. While it causes a temporary reduction in numbers, the population will typically rebound to its original average density once the chemical degrades. Permanent changes to the equilibrium require long-term environmental modifications, such as the introduction of new natural enemies or resistant varieties.

33. (B) V.M. Stern and colleagues
The foundational economic concepts of the Economic Injury Level and the Economic Threshold Level were first formalized and introduced by V.M. Stern and his colleagues in 1959. Their work provided the theoretical framework for Integrated Pest Management by emphasizing that pest control should be based on economic necessity rather than the mere

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presence of insects, revolutionizing agricultural decision-making processes.

34. (D) Cost of the pest management intervention per unit area
In the standard equation for calculating the Economic Injury Level, the variable C represents the total cost of the pest management intervention per unit area. This includes the price of the pesticide, labor, and equipment usage. As the cost of control increases, the calculated Economic Injury Level also rises, meaning a higher pest density is required to justify management expenditure.

35. (A) I, II and III
The Economic Injury Level is a dynamic metric influenced by several factors. An increase in management costs raises the threshold, while a higher market value for the crop lowers it. Mathematically, it represents the point where the cost of intervention equals the value of the damage prevented. It is not a static value and must be adjusted based on context.

36. (C) It will decrease the EIL, requiring earlier and more stringent pest interventions.
A significant increase in the global market value of a crop will mathematically decrease the Economic Injury Level. Because the crop is worth more, even small amounts of pest damage result in greater financial loss. Consequently, farmers must intervene at lower pest densities to protect their valuable yield, requiring more frequent or earlier management actions compared to price lows.

37. (A) The EIL increases, meaning a higher pest density is required to cause economic injury.
If the per-capita feeding efficiency of a pest is reduced, the amount of injury caused by each individual insect decreases. In the Economic Injury Level calculation, this leads to an increase in the threshold value. A higher population density can therefore be tolerated before the cost of damage equals the cost of control, reflecting the reduced impact of the pest.

38. (D) The EIL is completely independent of the crop's physiological growth stage during infestation.
The Economic Injury Level is highly dependent on the crop's physiological growth stage, as plants often exhibit varying levels of sensitivity to injury at different times. For example, a crop might tolerate significant defoliation during the vegetative stage but suffer severe yield loss if the same injury occurs during flowering. Management thresholds must therefore be adjusted dynamically throughout the growing season.

39. (B) The number of insects or amount of injury per unit of crop or area.
In practical agricultural terms, the Economic Injury Level is typically expressed as the number of insects or the amount of injury per unit of crop or area. For instance, it might be stated as five larvae per plant or twenty percent leaf defoliation. This measurable unit allows farmers and scouts to directly compare field observations with established management thresholds.

40. (A) Both A and R are true and R is the correct explanation of A.
The Economic Threshold Level is intentionally set at a lower density than the Economic Injury Level. This provides a critical buffer period, allowing management actions to be implemented and take effect before the growing pest population reaches the point of causing actual economic damage. This proactive approach is a cornerstone of Integrated Pest Management, ensuring interventions are timely and effective.

41. (D) Management action must be initiated to prevent the population from reaching the EIL.
The Economic Threshold Level, or Action Threshold, is defined as the pest density at which management action must be initiated to prevent an increasing population from reaching the Economic Injury Level. It serves as a practical warning signal for farmers. By intervening at this point, the grower ensures that the cost of control is justified by preventing significant yield loss.

42. (A) The ETL is a practical decision point for intervention, while the EIL is the damage limit to be avoided.
The primary operational difference between these metrics is their function in decision-making. The Economic Threshold Level is a practical field trigger used to initiate pest suppression, whereas the Economic Injury Level represents the theoretical limit of damage that must be avoided to maintain profitability. While both are related

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60. (B) Tolerance
R.H. Painter's classic framework defines the three core mechanisms of Host Plant Resistance as Antixenosis, Antibiosis, and Tolerance. These categories describe how plants interact with pests to reduce damage. Antixenosis affects insect behavior, Antibiosis impacts insect physiology and survival, and Tolerance represents the plant's ability to withstand injury without significant yield loss. Together, they form the basis for breeding.

61. (A) The non-preference of the insect for the plant as a site for oviposition, feeding, or shelter.
Antixenosis, a mechanism of host plant resistance, refers specifically to the non-preference of an insect for a plant as a site for oviposition, feeding, or shelter. This is often mediated by physical characteristics like trichomes or chemical repellents. By making the plant unattractive or difficult to utilize, antixenosis reduces the initial colonization and subsequent population growth of pests.

62. (C) Tolerance
Tolerance is a unique mechanism of host plant resistance where a crop variety supports the normal growth and reproduction of a pest but still produces an acceptable economic yield despite the damage. Unlike other mechanisms, it does not place selection pressure on the pest to evolve. This makes tolerance a durable and valuable trait in sustainable pest management systems.

63. (D) It heavily relies on the plant's structural modifications to physically deter the pest from landing.
Antibiosis involves adverse physiological effects on the insect life cycle, such as increased mortality or reduced fecundity, caused by feeding on a resistant plant. It is typically mediated by toxic secondary metabolites or nutritional deficiencies. It does not rely on structural modifications to deter landing; those physical barriers are instead characteristic of antixenosis. Antibiosis actively targets herbivore biology and survival.

64. (C) Antixenosis
The presence of dense trichomes on the leaves of a cotton variety is a classic example of antixenosis. These physical hairs act as a barrier that prevents insects like whiteflies from easily reaching the leaf surface to feed or lay eggs. By disrupting the behavioral preferences of the pest, the plant successfully reduces the overall level of infestation and damage.

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65. (C) I and III
Host Plant Resistance is highly compatible with biological control agents, as it often slows pest development or reduces populations without harming predators. However, strong antibiosis can exert intense selection pressure, leading to the rapid evolution of virulent pest biotypes that can overcome the resistance. Understanding these interactions is essential for the long-term durability and effectiveness of resistant varieties in programs.

66. (D) The rapid evolutionary selection of virulent pest biotypes capable of overcoming the resistance.
Implementing crop varieties with high levels of monogenic antibiosis carries the risk of rapid evolutionary selection of virulent pest biotypes. Because the resistance is based on a single gene, a small genetic change in the pest population can allow it to bypass the plant's defense. This breakdown of resistance highlights the importance of managing selection pressure through diverse breeding.

67. (A) Controlled by one or a few major genes (monogenic/oligogenic) and being highly specific to certain pest biotypes.
Vertical resistance is genetically characterized by being controlled by one or a few major genes. It is typically highly specific, providing complete protection against certain pest biotypes while being ineffective against others. While this type of resistance is easy for breeders to incorporate, it is also vulnerable to being overcome by new, virulent strains of the pest in agriculture.

68. (C) Polygenically inherited, providing durable, broad-spectrum, but incomplete protection.
Horizontal resistance is polygenically inherited, meaning it is controlled by many genes with small individual effects. This type of resistance provides durable, broad-spectrum protection against a wide range of pest biotypes. Although the protection is often incomplete, it is much harder for pests to overcome through simple mutations. Consequently, horizontal resistance is highly valued for providing long-lasting stability in programs.

51. (A) Destroying crop residues that serve as critical overwintering or diapausing sites.
Rigorous sanitation practices, such as removing weeds and burying crop residues, primarily disrupt pest life cycles by destroying essential overwintering and diapausing sites. Many pests rely on these materials to survive between growing seasons. By eliminating these refuges, farmers can significantly reduce the initial population size for the following year, thereby lowering the overall pest pressure on crops.

52. (C) It is most successful when used against highly polyphagous, highly mobile flying insects.
Crop rotation is highly effective against soil-dwelling pests and those with a narrow host range and limited mobility. However, it is generally less successful against highly polyphagous and highly mobile flying insects that can easily migrate from distant fields to locate their host. Its primary value lies in breaking the life cycle of specialized pests dependent on specific crops.

53. (A) Generates a more complex micro-environment that disrupts pest host-finding behavior.
Intercropping provides a primary ecological advantage by creating a more complex and diverse micro-environment within the field. This spatial heterogeneity disrupts the host-finding behavior of many pests by diluting olfactory cues and creating physical barriers. Additionally, the increased floral and habitat diversity often supports higher populations of natural enemies, which contribute to the natural regulation of pest species.

54. (D) Physical pest control
The application of specialized temperature treatments, such as heating or refrigeration, to disinfest stored agricultural grains is classified as a physical pest control method. These techniques rely on the manipulation of the physical environment to kill or inhibit the development of pests without the use of chemical residues. Such methods are particularly valuable for protecting stored products for human consumption.

55. (B) I, IV, II, III
Managing stored grain pests involves various thermal treatments. Refrigerated storage uses the lowest temperatures, followed by ambient aeration which utilizes outside air. Sun drying applies natural solar heat to reduce moisture and kill insects. Industrial superheating represents the highest level of applied heat, used for rapid and thorough disinfestation in commercial settings to ensure product safety and quality.

56. (C) Monitoring population density and mass trapping of small flying insects like aphids and thrips.
Colored sticky traps are widely used in agricultural fields and greenhouses to monitor the population density of small flying insects, such as aphids, thrips, and whiteflies. They are also employed for mass trapping to reduce localized pest pressure. By attracting insects with specific colors and capturing them on an adhesive surface, these tools provide essential data for management timing.

57. (D) Small to medium-sized flying insects seeking to oviposit on the crop foliage.
Physical exclusion barriers, such as finely meshed nylon nets, are practically most effective against small to medium-sized flying insects that attempt to land on crop foliage for feeding or egg-laying. By preventing the pests from reaching the plants, these barriers provide a non-chemical means of protection. They are commonly used in high-value vegetable production to maintain pest-free environments.

58. (A) Trenching around fields : Preventing the migration of crawling insect pests
Trenching is a mechanical control method used to prevent the migration of crawling insect pests, such as certain caterpillars or armyworms, from one field to another. By digging steep-sided trenches around the perimeter, the pests become trapped, where they can be destroyed or left to perish. This physical intervention is a simple and effective way to halt infestations.

59. (B) Spraying an organophosphate insecticide to induce neural paralysis
While manual hand-picking, trenching, and the application of abrasive diatomaceous earth are considered physical or mechanical control methods, spraying an organophosphate insecticide is a chemical intervention. Physical methods rely on tangible barriers or manual removal to manage pests, whereas chemical methods utilize toxic substances to disrupt the physiological or neurological processes of the target organism to achieve mortality in fields.

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pesticide treadmill necessitated a transition to management systems that prioritize ecological stability and multi-faceted control methods to maintain agricultural productivity.

9. (D) Agronomic manipulations such as adjusting planting dates and sanitation.
Historically, pest management relied on traditional agronomic manipulations to reduce insect pressure. These cultural practices included adjusting planting and harvesting dates to create asynchrony with pest life cycles, implementing field sanitation to remove overwintering sites, and using crop rotation to disrupt host availability. These methods were foundational because they utilized existing farming activities to proactively minimize pest populations without chemicals.

10. (D) A is false but R is true.
While early broad-spectrum pesticides provided immediate control, they failed to achieve permanent eradication of key agricultural pests. Instead, these chemicals often decimated beneficial natural enemy populations, leading to severe ecological imbalances and subsequent pest outbreaks. The survival of resistant individuals allowed populations to rebound quickly, proving that chemical-only strategies are unsustainable and ecologically damaging over long durations in agricultural systems.

11. (B) Often required region-wide synchronization to be effectively preventative.
A significant limitation of traditional cultural control methods is their reliance on wide-scale coordination among farmers. Tactics like synchronized planting or communal field sanitation are often ineffective if only practiced by a few individuals, as pests can easily migrate from neighboring untreated fields. To be truly preventative, these practices require collective action across an entire landscape to effectively suppress populations.

12. (B) Accepting the permanent presence of pests and maintaining them at tolerable levels.
The conceptual shift from pest control to pest management represents an evolution in agricultural philosophy. Rather than attempting the total eradication of herbivorous insects, modern management focuses on accepting their presence in the ecosystem while maintaining their populations below levels that cause economic loss. This approach emphasizes long-term sustainability, ecological balance, and the cost-effective use of integrated suppression techniques.

13. (A) Using agro-ecosystem dynamics and natural mortality to regulate pests.
Integrated Pest Management is philosophically grounded in the utilization of natural mortality factors and agro-ecosystem dynamics. It prioritizes the conservation of predatory and parasitic organisms alongside cultural practices to keep pest densities low. By understanding ecological interactions, farmers can manage pests in a way that minimizes environmental disruption while ensuring that the system remains resilient and self-regulating over time.

14. (C) Optimizing the cost-benefit ratio of pest interventions while safeguarding health.
A primary socio-economic goal of Integrated Pest Management is to optimize the financial returns of agricultural production by balancing the costs of intervention with the value of yield protection. Simultaneously, it aims to safeguard public health and the environment by reducing human exposure to toxic residues. This multi-objective framework ensures that pest management remains profitable, socially acceptable, and ecologically sound.

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15. (B) II and III
Core principles of Integrated Pest Management focus on the integration of multiple compatible tactics, such as biological, cultural, and chemical controls, to achieve effective pest suppression. The primary objective is to maintain pest populations below the Economic Injury Level through continuous monitoring. Unlike older approaches, it avoids routine, calendar-based chemical applications, instead relying on field data for necessary action.

16. (C) Low pest populations are necessary to sustain resident natural enemy populations.
Integrated Pest Management programs intentionally tolerate low, sub-economic densities of pests to ensure the survival and retention of resident natural enemies. These beneficial predators and parasitoids require a consistent food source or host population to remain established in the field. By maintaining this ecological balance, the agro-ecosystem preserves its natural capacity for self-regulation, preventing future outbreaks of pests.

69. (A) Midgut epithelial cells
The crystalline endotoxins produced by Bacillus thuringiensis and expressed in transgenic crops specifically target the midgut epithelial cells of susceptible insects. Upon ingestion, the toxins bind to specific receptors, causing pores to form in the gut lining. This leads to gut paralysis, starvation, and eventually the death of the insect, providing a highly specific and effective method for management.

70. (A) Both A and R are true and R is the correct explanation of A.
The widespread cultivation of Bt-cotton has significantly reduced the need for broad-spectrum chemical insecticides, particularly for managing bollworms. Because the plants continuously express lethal Cry toxins, the pests are controlled throughout the season without the need for external sprays. This reduction in chemical use has led to decreased production costs, lower environmental impact, and enhanced safety for workers.

71. (B) The high-dose/refuge strategy is a mandatory IRM tactic used to delay pest resistance to Bt crops.
The high-dose/refuge strategy is a mandatory insecticide resistance management tactic used to delay the development of pest resistance to Bt crops. It involves planting a portion of the field with non-Bt varieties to maintain a population of susceptible insects that can mate with any resistant individuals. This keeps resistance genes rare in the population, extending technology commercial lifespan.

72. (C) The rapid selection and proliferation of Bt-resistant pest populations.
A major long-term risk associated with the unmanaged reliance on monogenic Bt crops is the rapid selection and proliferation of Bt-resistant pest populations. Constant exposure to the same toxin creates intense evolutionary pressure. If resistance management strategies like refugia are not strictly followed, the target pests can evolve to survive the toxin, rendering the transgenic technology completely ineffective.

73. (D) Polygenic resistance
Polygenic resistance is most commonly associated with conferring horizontal resistance in agricultural crops. Because it is governed by multiple genes, it provides a stable and broad level of protection that is difficult for pests to overcome. This contrast with monogenic resistance makes polygenic traits essential for developing durable varieties that maintain their effectiveness over many years across diverse environmental conditions.

74. (A) The deliberate introduction and permanent establishment of an exotic natural enemy to control an invasive exotic pest.
Classical biological control involves the deliberate introduction and permanent establishment of an exotic natural enemy to control a non-native, invasive pest. This strategy aims to restore the ecological balance that existed in the pest's area of origin. Once the natural enemy is established, it provides long-term, self-sustaining regulation of the pest population without the need for repeated interventions.

75. (A) I, II and IV
Biological control involves various agents and strategies. Parasitoids typically complete their development on a single host, eventually killing it, while predators consume multiple prey individuals throughout their lives. Inundative release is a form of augmentative control where large numbers of agents are released for immediate suppression. Understanding these distinct roles is crucial for selecting appropriate agents for Integrated programs.

76. (B) Develops in or on a single host individual, eventually killing it.
A primary biological difference between an insect parasitoid and a predator is their host utilization. A parasitoid develops entirely within or on a single host individual, eventually leading to the host's death. In contrast, a predator is typically larger than its prey and must consume many individuals throughout its life cycle to survive. This makes parasitoids highly specialized for regulation.

77. (A) The application of a rapid-action chemical insecticide.
The inundative release strategy in augmentative biological control is conceptually similar to the application of a rapid-action chemical insecticide. It involves the mass release of natural enemies to achieve an immediate knockdown of a pest population. Unlike classical biological control, it does not aim for permanent establishment, but

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a vulnerable stage, farmers can optimize the timing of monitoring and suppression activities.

128. (C) Incorporate the underlying biological, physiological, and ecological processes driving population changes.
Mechanistic simulation models differ from purely empirical statistical models because they incorporate the underlying biological, physiological, and ecological processes that drive population changes. By simulating interactions such as feeding, reproduction, and mortality, these models provide a deeper understanding of how pests respond to different factors. This process-based approach makes them highly valuable for long-term strategic planning.

129. (B) They completely eliminate the need for any actual field scouting or empirical surveillance by the farmer.
Predictive mathematical models are essential components of modern Decision Support Systems, but they do not eliminate the need for actual field scouting and empirical surveillance. Models provide forecasts based on data, but real-world conditions vary significantly. Ground-trunthed through regular monitoring remains necessary to validate model predictions and ensure that management actions are appropriate for actual pest pressures.

130. (A) Both A and R are true and R is the correct explanation of A.
Systems approach modeling in Integrated Pest Management requires continuous validation with real-world field data because agro-ecosystems are complex and highly variable. Without verification, models may produce inaccurate predictions that lead to significant crop loss or excessive chemical use. Ongoing validation ensures that models remain reliable tools for decision-making, helping farmers navigate the dynamic interactions between pests and crops.

131. (A) A range of outcomes accompanied by calculated probabilities of occurrence based on environmental variability.
A stochastic simulation model used to forecast regional pest outbreaks will provide a range of potential outcomes accompanied by calculated probabilities of occurrence. By incorporating random environmental variability, these models reflect the inherent uncertainty in biological systems. This probabilistic output allows managers to assess risks and prepare for multiple scenarios, leading to more resilient management strategies.

132. (C) Clipping the tips of rice seedlings prior to transplanting to remove egg masses.
The standard Integrated Pest Management module for the rice yellow stem borer emphasizes early-season cultural practices, such as clipping the tips of rice seedlings prior to transplanting. This simple mechanical method removes any existing egg masses, significantly reducing the initial pest population in the main field. This proactive approach minimizes early-season damage and reduces subsequent chemical interventions in rice.

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133. (A) Late-instar lepidopteran larvae such as Helicoverpa armigera.
In cotton Integrated Pest Management, the strategic installation of vertical bird perches is recommended to encourage active predation by insectivorous birds. These perches provide a vantage point for birds to locate and consume late-instar lepidopteran larvae, such as Helicoverpa armigera. By enhancing avian predators, farmers can leverage natural biological control to reduce pest pressure and minimize chemical reliance.

134. (D) Sugarcane pyrilla : Conservation and redistribution of Epiricania melanoleuca
The management of sugarcane pyrilla is a classic success story in biological control, relying on the conservation and redistribution of the parasitoid Epiricania melanoleuca. This natural enemy is highly effective at suppressing pyrilla populations. IPM modules for sugarcane prioritize monitoring these parasitoids and avoid disruptive chemical applications, ensuring that natural regulation remains the primary defense against this pest.

135. (A) I, II, III and V
Standard Integrated Pest Management modules for major crops integrate multiple tactics. In rice, avoiding excessive nitrogen prevents planthopper resurgence. Cotton benefits from summer ploughing to destroy pupae and mandatory refugia for Bt varieties. Pulse crops utilize pheromone traps for population monitoring. These coordinated strategies provide robust, long-term pest suppression while minimizing environmental impact and protecting economic viability.

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the viral DNA, rendering the occlusion bodies inactive and significantly reducing their efficacy. To mitigate this effect, NPV applications are often timed for late afternoon or evening, and formulations may include UV protectants to extend activity.

87. (B) Benefit the receiving organism while being adaptively disadvantageous to the emitting organism.
Kairomones are interspecific semiochemicals that provide an adaptive advantage to the receiving organism while being disadvantageous to the emitter. For example, a predator may use the chemical cues produced by its prey to locate a food source. These chemical signals play a critical role in the searching behavior of many natural enemies, making them important components in ecological interactions.

88. (C) Sex pheromones
Mating disruption is a behavioral control technique that utilizes field-wide permeation with high concentrations of synthetic sex pheromones. By saturating the environment with the scent of females, males become confused and are unable to locate potential mates. This prevents reproduction and leads to a significant decline in the pest population over time, providing a species-specific and environmentally safe solution.

89. (D) Emitting organism (producer)
An allomone is a type of allelochemical that provides an adaptive evolutionary advantage primarily to the emitting organism. These substances are often used as chemical defenses to repel predators or deter herbivores. By producing allomones, the organism can protect itself from being consumed or attacked, thereby increasing its chances of survival and reproduction within its ecological niche in fields.

90. (A) It is highly successful even against rapidly migrating pest populations from surrounding uncontrolled areas.
Mass trapping is most effective when implemented over large, isolated geographic areas against localized pest populations. However, it is generally unsuccessful against rapidly migrating pests that continuously move in from surrounding uncontrolled regions, as the traps cannot keep pace with the influx. This strategy requires a high density of traps and careful coordination to achieve significant reductions in population levels.

91. (B) Precision and timing of targeted insecticidal applications.
The use of synthetic sex pheromone traps to monitor the timing of pest emergence is fundamentally aimed at refining the precision and timing of targeted management interventions. By knowing exactly when the pests are active, farmers can apply treatments at the most susceptible life stage. This increases management efficacy while reducing the total number of applications needed in the field.

92. (B) Evoke a behavioral or physiological response that is adaptively favorable to both the emitter and the receiver.
Synomones are interspecific chemical messengers that evoke a behavioral or physiological response adaptively favorable to both the emitting and the receiving organism. A classic example is the floral scents that attract pollinators; the plant achieves fertilization while the insect receives food. These mutualistic signals are essential for many beneficial ecological interactions that support agricultural productivity and natural pest regulation.

93. (A) Mass rearing and releasing millions of competitive, sterile males to mate with wild fertile females.
The Sterile Insect Technique relies on the mass rearing and release of millions of competitive, sterile male insects into the environment. When these sterile males mate with wild fertile females, no offspring are produced. Over successive generations, this leads to a dramatic decline or even the local eradication of the target pest population. It is a highly specific form of control.

94. (C) Screwworm fly (Cochliomyia hominivorax)
The Sterile Insect Technique was first conceptualized and successfully employed on a large scale to permanently eradicate the screwworm fly from North and Central America. This milestone demonstrated the power of autocidal control for managing major pests. The program's success saved the livestock industry billions of dollars and paved the way for the application of SIT to other insects.

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mixes and managing the long-term efficacy of chemical control.

111. (D) Physical/Chemical incompatibility
Tank mixing two pesticides that react chemically to cause precipitation or clogged nozzles is an example of physical or chemical incompatibility. These reactions can reduce the effectiveness of the treatment, damage spraying equipment, and potentially cause phytotoxicity to the crop. Before mixing different products, it is vital to perform a jar test to ensure they are compatible and function safely.

112. (C) Enhances natural enemy abundance and effectiveness by providing alternative prey, nectar, and stable microhabitats.
The enemies hypothesis suggests that increased plant diversity within an agricultural field enhances the abundance and effectiveness of natural enemies. Diverse environments provide alternative prey, floral resources like nectar, and stable microhabitats that support a wider range of predators and parasitoids. By fostering a robust beneficial community, high biodiversity helps maintain pest populations at lower densities, reducing chemical needs.

113. (B) General Equilibrium Position (GEP) well below the Economic Injury Level.
A robust and complex food-web structure within an agro-ecosystem typically leads to a biological state where pest populations remain near their General Equilibrium Position, well below the Economic Injury Level. The presence of diverse natural enemies ensures that pests are regulated through multiple mortality factors. This ecological stability minimizes the occurrence of outbreaks and promotes sustainable protection through natural mechanisms.

114. (D) They actively contribute to the rapid evolutionary development of insecticide resistance in pests.
Natural enemy reservoirs, such as hedgerows and uncultivated field margins, provide critical refuges and overwintering sites for beneficial insects. These habitats do not contribute to the evolutionary development of insecticide resistance in pests; instead, they help maintain the biological diversity required for effective natural pest regulation. By supporting parasitoids and predators, these areas are vital components of Integrated Management.

115. (C) I and III
Biodiversity plays a crucial role in pest regulation. Monocultures often lack the diverse microhabitats needed to sustain natural enemies, whereas polycultures and spatial heterogeneity provide the resources that polyphagous predators require. While increased biodiversity enhances natural control, it does not guarantee the absolute elimination of all key pests. Strategic habitat management is necessary to maximize the benefits of diversity.

116. (C) Lifespan, fecundity, and searching efficiency of adult parasitoid wasps.
Providing selected floral resources on field margins is an ecological tactic aimed at enhancing the biological performance of adult parasitoid wasps. Nectar and pollen provide essential nutrients that increase their lifespan, fecundity, and searching efficiency. By supporting these beneficial insects, farmers can improve the natural suppression of pests, making the overall Integrated Pest Management program more effective and sustainable.

117. (A) Predators, parasitoids, and entomopathogens consuming the herbivores.
In ecological food-web interactions, top-down regulation refers to the control of pest populations by organisms at higher trophic levels, such as predators, parasitoids, and entomopathogens. These natural enemies limit herbivore numbers through consumption or infection. Enhancing these top-down pressures is a primary goal of Integrated Pest Management, as it leverages natural biological processes to maintain thresholds.

118. (D) Extensive monoculture systems
The resource concentration hypothesis explains why pest outbreaks are more frequent and severe in extensive monoculture systems. When a single host plant is grown over a large area, pests can easily locate, colonize, and exploit this abundant food source. The lack of physical and biological barriers in monocultures facilitates rapid population growth, making these systems highly vulnerable to infestations.

119. (B) Disrupted pest host-finding behaviors and enhanced natural enemy activity.
Polycultures typically experience reduced pest herbivory compared to monocultures due to two main ecological mechanisms. First, the presence

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103. (B) They cause immediate "knock-down" mortality within minutes of application.
Insect Growth Regulators do not cause immediate knockdown mortality upon application. Instead, they work slowly by disrupting the hormonal and developmental processes of the insect. While they are environmentally friendly and have low mammalian toxicity, their slow action requires precise timing targeting specific developmental windows. Farmers must understand this delay to properly evaluate the effectiveness of IGR treatments in the field.

104. (C) The formation of lethal larval-pupal intermediates or supernumerary larval instars.
Juvenile hormone analogues applied to late-instar larvae typically result in the formation of lethal larval-pupal intermediates or extra, supernumerary larval instars. By mimicking the hormone that maintains the juvenile state, these chemicals prevent the insect from successfully transitioning to the adult stage. This disruption of metamorphosis ensures that the pest never reaches reproductive maturity, effectively halting population growth within the crop.

105. (D) The fermentation process of the soil actinomycete Saccharopolyspora spinosa.
Spinosad is a highly effective biorational insecticide derived from the fermentation process of the soil actinomycete Saccharopolyspora spinosa. It combines the efficacy of synthetic chemicals with the safety profile of biological products. Spinosad targets the nervous system of many pests, particularly lepidopterans and thrips, but has a favorable environmental profile and low toxicity to most beneficial insects and vertebrates.

106. (A) Manipulating the timing, placement, or formulation of the application to avoid natural enemies.
Ecological selectivity is achieved by manipulating the timing, placement, or formulation of a pesticide application to minimize exposure to non-target natural enemies. For example, applying a chemical when predators are inactive or using systemic treatments that only affect feeding herbivores protects the beneficial community. This strategic approach allows for the use of materials within an Integrated framework while preserving regulation.

107. (B) Be inherently more toxic to the target pest species than to non-target natural enemies due to differences in metabolism or target-site physiology.
Physiological selectivity refers to a pesticide's inherent ability to be more toxic to a target pest than to beneficial organisms due to biochemical differences. These differences may include varying rates of metabolic detoxification or unique target-site sensitivities. Utilizing physiologically selective chemicals is a preferred strategy in IPM, as it directly protects natural enemies while providing effective control of pest populations.

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108. (B) Rotating insecticides with distinctly different modes of action (MoA) to reduce consistent selection pressure.
Insecticide Resistance Management primarily advocates for the rotation of insecticides with distinctly different modes of action. By changing the chemical target site in successive generations, the consistent selection pressure on the pest population is reduced. This prevents the rapid buildup of resistant individuals and extends the useful life of available pesticides, ensuring that chemical control remains a viable agricultural tool.

109. (A) Develop a specific physiological resistance mechanism that coincidentally confers resistance to other, unexposed insecticides sharing a similar mode of action.
Cross-resistance occurs when an insect population develops a specific resistance mechanism that simultaneously provides protection against other, unexposed insecticides sharing a similar mode of action or metabolic pathway. This phenomenon complicates pest management because the failure of one chemical can lead to the failure of an entire class of insecticides, emphasizing the need for rotating between diverse groups.

110. (B) P-3, Q-4, R-2, S-1
Pesticide interactions and resistance are complex. Synergism occurs when mixtures are more toxic than individual components, while antagonism describes reduced toxicity. Cross-resistance involves a single pathway protecting against similar chemicals, whereas multiple resistance involves separate co-existing mechanisms for different insecticide classes. Understanding these terms is essential for developing effective tank

rather provides a quick, short-term solution to an existing pest outbreak.

78. (C) It involves the continuous importation of exotic parasitoids from foreign countries.
Conservation biological control focuses on modifying the environment to protect and enhance existing native natural enemy populations. This includes providing floral resources and reducing pesticide use. It does not involve the continuous importation of exotic species from foreign countries; that practice is instead characteristic of classical biological control. The goal of conservation is to maximize the effectiveness of beneficial organisms.

79. (D) Mealybugs
Cryptolaemus montrouzieri, commonly known as the mealybug destroyer, is a specialized ladybird beetle predator used extensively to manage mealybug infestations. Both the adults and larvae of this beetle actively prey on various species of mealybugs across different crops. This biological control agent is particularly effective in orchards and greenhouses, providing significant suppression of these difficult-to-control sap-sucking pests without residues.

80. (A) P-1, Q-4, R-2, S-3
Microbial control agents utilize diverse infection mechanisms. Bacillus thuringiensis is ingested and targets the midgut, while Beauveria bassiana penetrates the insect cuticle directly. Nuclear Polyhedrosis Viruses cause larval liquefaction and are highly specific. Entomopathogenic nematodes release lethal mutualistic bacteria into the host's body. These biological tools offer specific, environmentally friendly alternatives to synthetic chemicals in Integrated Pest Management programs.

81. (B) Direct penetration and colonization through the external cuticle/integument.
Entomopathogenic fungi, such as Metarhizium anisopliae, are unique among microbial agents because they primarily infect insect hosts through direct penetration of the external cuticle. Unlike bacteria and viruses that must be ingested, fungal spores can germinate on the insect's surface and colonize its body. This makes them particularly effective against sucking insects and other pests that do not consume foliage.

82. (D) Lepidoptera
Formulations of Nuclear Polyhedrosis Viruses are most highly effective and routinely utilized against pests belonging to the order Lepidoptera, which includes various moths and butterflies. These viruses are extremely host-specific and cause a systemic infection that eventually leads to the liquefaction of larval tissues. Their high specificity makes them ideal for inclusion in management programs targeting caterpillars.

83. (A) Xenorhabdus and Photorhabdus
Entomopathogenic nematodes achieve rapid insect mortality through an obligate mutualistic relationship with lethal bacteria from the genera Xenorhabdus and Photorhabdus. Once the nematode enters the insect's body, it releases these bacteria into the hemocoel. The bacteria then multiply rapidly, causing septicemia and killing the host within 24 to 48 hours. This synergy makes these nematodes highly effective agents.

84. (C) They exhibit high target specificity and generally have minimal impact on beneficial natural enemies.
Commercial formulations of Bacillus thuringiensis are highly valued for their high target specificity and minimal impact on beneficial natural enemies. Because the Cry toxins only affect specific insect groups with the correct midgut receptors, they do not harm predators, parasitoids, or pollinators. This safety profile makes Bt an excellent choice for integrated programs where conserving biological diversity is priority.

85. (B) III, IV and V
Several biological factors limit the use of microbial agents. Bacillus thuringiensis requires an alkaline, not acidic, midgut environment to activate its toxins. Entomopathogenic nematodes are highly sensitive to desiccation and are generally ineffective in dry environments. Furthermore, most microbial products have a much shorter shelf-life than synthetic chemicals. Understanding these limitations is essential for ensuring effective field application.

86. (D) Intense solar ultraviolet (UV) radiation
Intense solar ultraviolet radiation is considered the most detrimental environmental factor affecting the field persistence of sprayed Nuclear Polyhedrosis Viruses. UV light rapidly degrades

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of multiple plant species disrupts the host-finding behavior of specialized pests. Second, the increased structural and floral diversity enhances the activity and abundance of natural enemies. Together, these factors create a more resilient environment where pests are naturally suppressed behaviorally.

120. (C) Preserving soil structure and crop residues, which enhances populations of epigeal predators like carabid beetles.
Conservation agriculture practices, such as zero or minimum tillage, influence pest dynamics by preserving soil structure and crop residues. This creates a favorable habitat for epigeal predators like carabid and staphylinid beetles, which prey on soil-dwelling and ground-migrating pests. By enhancing these natural enemy populations, conservation agriculture supports biological regulation and contributes to the overall stability of the agro-ecosystem.

121. (D) Organic mulches provide favorable microhabitats that can significantly increase the abundance of generalist ground predators.
Organic mulches provide favorable microhabitats that can significantly increase the abundance of generalist ground predators, such as spiders and predatory beetles. These beneficial organisms help suppress pest populations near the soil surface. While mulching does not guarantee the complete eradication of pests, it is a valuable cultural practice that enhances biological control and improves soil health within frameworks.

122. (A) Successive monocropping of the same highly susceptible host plant
Successive monocropping of the same highly susceptible host plant is a practice that usually increases the localized proliferation and spread of soil-borne pests and nematodes. Continuous cultivation allows these organisms to build up their populations over time without interruption. To manage these pests effectively, farmers should implement crop rotation with non-host species, which breaks the life cycle.

123. (B) Repellent intercrops (push) and highly attractive trap crops (pull).
Push-pull technology is a sustainable farming strategy that utilizes strategic spatial arrangements of plants. It involves using repellent intercrops to push pests away from the main crop and highly attractive trap crops to pull them toward the field margins. This system not only manages pests but often improves soil fertility, making it a highly effective Integrated Pest Management approach.

124. (B) The rapid, unimpeded spatial dispersal and exponential growth of pest populations.
Extensive, unbroken agricultural monocultures remove the natural physical and ecological barriers that normally restrict insect movement. This allows for the rapid, unimpeded spatial dispersal and exponential growth of pest populations across the landscape. The lack of host diversity and habitat fragmentation in these systems makes them highly susceptible to large-scale outbreaks, necessitating intensive monitoring and management.

125. (A) III only
While mechanistic and simulation models are powerful tools for understanding pest dynamics, empirical statistical models are not universally applicable without local calibration. Because they are based on historical correlations from specific sites, their accuracy depends on local environmental conditions. All predictive models in IPM require high-quality meteorological data and validation with real-world observations to ensure they provide reliable guidance.

126. (C) An interactive, computer-based tool integrating data, models, and knowledge to assist farmers in making optimal pest choices.
A Decision Support System in the context of Integrated Pest Management is an interactive, computer-based tool that integrates data, mathematical models, and expert knowledge. It assists farmers and consultants in making optimal choices regarding pest interventions. By analyzing real-time information on weather and pest densities, a DSS provides tailored recommendations that enhance management efficiency and reduce chemical use.

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127. (D) Phenological timing of specific pest life stages, such as egg hatch or adult emergence.
Degree-day models are standardized mathematical tools used in Integrated Pest Management to predict the phenological timing of specific pest life stages, such as egg hatching or adult emergence. These models track accumulated heat units, which drive insect development. By accurately forecasting when pests will reach

effective and sustainable than previous chemical-intensive strategies causing resurgence.

145. (A) Prophylactic spraying → Destruction of natural enemies → Pest resurgence/Resistance → Crisis phase → Implementation of IPM
The historical transition to Integrated Pest Management typically begins with an era of prophylactic chemical spraying. This leads to the destruction of natural enemies, causing pest resurgence and the development of insecticide resistance. As chemical control becomes increasingly ineffective and expensive, a crisis phase emerges. Finally, this failure necessitates the implementation of IPM programs that prioritize ecological balance.

146. (D) The cotton bollworm complex (primarily Helicoverpa armigera)
The widespread failure of cotton cultivation in the late 1990s was largely precipitated by the development of extreme multi-chemical resistance in the cotton bollworm complex, primarily Helicoverpa armigera. The pest's ability to survive various insecticide classes led to devastating crop losses and financial ruin for many farmers. This crisis highlighted the critical need for sustainable management and accelerated adoption.

147. (A) Developed extreme, rapid resistance to almost every available class of synthetic chemical insecticide.
The global shift toward Integrated Pest Management for the Diamondback Moth was driven by the pest's extraordinary ability to develop rapid resistance to almost every class of synthetic insecticide. This chemical failure rendered traditional control methods obsolete. Modern DBM management now integrates biological agents and parasitoids with cultural practices, providing a more resilient and effective strategy for farmers.

148. (C) It heavily emphasized routine scouting, economic thresholds, IRM strategies, and the use of HaNPV.
Prior to the widespread adoption of Bt-cotton, Integrated Pest Management for the cotton bollworm in India relied on a combination of intensive field scouting, the use of economic thresholds, and insecticide resistance management strategies. It also incorporated the application of biological agents like HaNPV. This approach aimed to maximize the efficacy of available tools while minimizing environmental damage.

149. (A) The insecticide-induced mortality of highly effective natural predators, particularly lycosid spiders.
The catastrophic ecological resurgence of the rice Brown Planthopper in the 1970s and 1980s was scientifically linked to the insecticide-induced mortality of natural predators, specifically lycosid spiders. Over-reliance on broad-spectrum chemicals eliminated these beneficial organisms, which are essential for regulation. This imbalance allowed populations to explode, demonstrating that chemical-heavy strategies can inadvertently create more severe pest problems.

150. (D) The lack of extension services, organized training, and quality-controlled biological inputs.
An institutional constraint to the adoption of Integrated Pest Management refers to systemic issues such as a lack of effective extension services, organized farmer training, and access to quality-controlled biological inputs. These barriers prevent the successful transfer of IPM technology from research centers to actual farms. Overcoming these constraints requires significant policy support and investment in agricultural infrastructure and education.

151. (B) High initial cost and lack of availability of biological agents compared to cheap, subsidized chemical pesticides.
The widespread adoption of Integrated Pest Management by smallholder farmers is consistently impeded by the high initial cost and limited availability of biological control agents compared to cheap, often subsidized chemical pesticides. While IPM offers long-term benefits, immediate financial and logistical barriers make chemicals a more accessible option. Addressing these market imbalances is essential for promoting sustainable practices.

152. (D) Synthetic broad-spectrum pesticides are generally much harder to physically apply to a field than complex biological agents.
Technological constraints currently limiting IPM include poor quality control and short shelf-lives of biopesticides, as well as the need for accurate localized meteorological data for forecasting models. However, the claim that synthetic broad-spectrum pesticides are harder to apply is incorrect; their ease of use is a primary reason for

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136. (C) Diapausing pupae of Helicoverpa armigera resting in the soil profile.
Deep summer ploughing is a highly recommended cultural Integrated Pest Management tactic for pulse crops. By turning the soil during the hot summer months, the diapausing pupae of Helicoverpa armigera are exposed to intense solar heat and natural predators. This practice significantly reduces the overwintering population, leading to lower pest pressure during the following season and reducing chemical needs.

137. (D) Routine application of broad-spectrum organochlorine insecticides during the vegetative stage.
The IPM module for the chickpea pod borer emphasizes bird perches, NPV applications, and intercropping to attract parasitoids. Routine application of broad-spectrum organochlorine insecticides is not recommended, as it is contrary to the IPM philosophy. Such chemicals destroy natural enemies and encourage resistance. Instead, management focuses on integrating biological and cultural methods to achieve sustainable and effective suppression.

138. (A) Mango mealybug nymphs crawling up the trunk from the soil.
In mango Integrated Pest Management, applying slippery or sticky bands around the main tree trunks specifically targets mango mealybug nymphs. These insects crawl up from the soil to reach the canopy. The physical barriers prevent them from infesting inflorescences and fruits. This simple mechanical intervention is highly effective and reduces the need for foliar chemical sprays in orchards.

139. (B) Heavy, prophylactic applications of synthetic pyrethroids are recommended to eradicate the pest.
Management of the citrus leaf miner in Integrated Pest Management focuses on protecting new vegetative flushes using Neem Seed Kernel Extract and conserving native parasitoids. Heavy, prophylactic applications of synthetic pyrethroids are not recommended because they decimate beneficial insect populations and can lead to secondary pest outbreaks. Successful management relies on combinations of targeted interventions that preserve ecological balance.

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140. (D) P-3, Q-4, R-1, S-2
Horticultural trap cropping involves planting specific species to divert pests. Marigolds are used for Helicoverpa in tomato, and mustard is used for diamondback moths in cabbage. Okra serves as a trap for Earias in cotton, while castor attracts Spodoptera in groundnut. These strategic plantings help concentrate pest populations, allowing for more efficient management while reducing the chemical burden.

141. (A) Marigold
The Integrated Pest Management module for tomato fruit borer utilizes marigold as a strategic trap crop. Marigolds are highly attractive to Helicoverpa armigera moths for egg-laying. By planting rows of marigolds among tomatoes, the pest's oviposition is diverted away from the main crop. This reduces larval damage to tomatoes and allows for easier monitoring and targeted management.

142. (C) The Diamondback Moth (DBM) and aphids
In the cultivation of cabbage and other crucifers, Indian mustard is planted as a peripheral trap crop to attract and concentrate the Diamondback Moth and various aphid species. These pests prefer mustard foliage for feeding and reproduction. By concentrating the infestation on mustard plants, farmers can reduce pest pressure on the main cabbage crop and apply localized treatments.

143. (D) Antifeedant and potent oviposition deterrent.
Foliar sprays of Neem Seed Kernel Extract in crucifer management are primarily intended to function as an antifeedant and potent oviposition deterrent. The complex limonoids in neem disrupt the feeding behavior of larvae and prevent adult moths from laying eggs on treated foliage. This botanical intervention is highly compatible with biological control agents, making it an essential tool.

144. (C) Minimizing disruptive insecticide use to conserve natural spider and bug predators.
The landmark success in managing the Brown Planthopper in Asian rice systems was achieved by minimizing the use of disruptive broad-spectrum insecticides. This shift allowed for the conservation of highly effective natural predators, particularly spiders and predatory bugs, which naturally regulate BPH populations. This ecologically-based approach proved far more

95. (D) Utilizing transgenic constructs to induce stage-specific lethality without the debilitating physical effects of massive radiation.
The RIDL strategy improves upon classical SIT by utilizing transgenic constructs to induce stage-specific lethality in offspring. This avoids the debilitating physical damage caused by the high doses of radiation used in traditional sterilization. Consequently, released RIDL insects are often more competitive and healthier, which enhances the efficiency of the control program and increases the likelihood of successfully suppressing wild populations.

96. (C) It is primarily utilized against Lepidopteran pests, where sub-sterilizing doses produce sterile offspring in the next generation.
Inherited sterility, or F_1 sterility, is an autocidal control mechanism primarily utilized against lepidopteran pests. It involves exposing the parental generation to sub-sterilizing doses of radiation. While the parents remain partially fertile, their offspring are completely sterile. This approach is more efficient than full sterilization because the released individuals are more physically robust and competitive in the field, leading to better suppression.

97. (B) Suppressed to a very low density using prior chemical or cultural control methods.
For a Sterile Insect Technique program to be successful, the wild pest population must initially be suppressed to a very low density using other methods like chemical or cultural control. A low wild population ensures that the released sterile males significantly outnumber the fertile wild males, maximizing the probability of sterile matings. This numerical advantage is critical for eradication.

98. (D) The female of the species mates multiple times daily with different males.
A pest species is poorly suited for the Sterile Insect Technique if the females mate multiple times daily with different males. This behavior increases the likelihood that a female will eventually mate with a fertile wild male, counteracting the effects of matings with sterile released males. SIT is most effective for species where females mate only once or where sperm is competitive.

99. (A) Are generally highly effective against target pests but possess low toxicity to non-target organisms and the environment.
Biorational insecticides are chemical formulations that are highly effective against target pests but possess very low toxicity to non-target organisms, humans, and the environment. These products often have unique modes of action and degrade rapidly. Their favorable safety profiles make them ideal components of Integrated Pest Management programs that prioritize ecological health and long-term sustainability in agricultural production systems.

100. (A) Both A and R are true and R is the correct explanation of A.
Insect Growth Regulators are excellent components of Integrated Pest Management because of their high physiological selectivity. While they may have a slow speed of kill, they specifically disrupt insect-only processes like molting or chitin synthesis. This makes them relatively harmless to adult natural enemies, pollinators, and vertebrate animals. Their use helps maintain ecological balance while effectively managing pest populations.

101. (A) Antifeedant and insect growth disruptor (ecdysone antagonist).
Azadirachtin, the primary active compound in neem seeds, exerts its physiological effect as a potent antifeedant and insect growth disruptor. It acts as an ecdysone antagonist, interfering with the hormonal regulation of molting and metamorphosis. By preventing insects from feeding and developing properly, it effectively reduces pest populations while remaining relatively safe for non-target organisms and the overall agricultural environment.

102. (D) Immature larval or nymphal stages, specifically prior to molting.
Chitin synthesis inhibitors are most effective when applied to immature larval or nymphal stages of insects, specifically prior to the molting process. These compounds prevent the formation of a new exoskeleton, leading to the death of the insect during or immediately after it attempts to shed its old skin. Because adults have already completed their growth, they are generally less affected.

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continued popularity. IPM's knowledge-intensive nature remains a greater challenge.

153. (D) Cognitive and educational constraint to IPM adoption.
The high initial knowledge requirement and the steep learning curve for accurate pest identification, field scouting, and threshold calculation are formally considered cognitive and educational constraints to Integrated Pest Management adoption. Unlike simple scheduled spraying, IPM requires farmers to make complex, data-driven decisions. This intellectual burden can be significant, necessitating comprehensive participatory training programs to build capacity.

154. (A) Highly visible, rapid, and predictable immediate mortality of the pest population.
Farmers in risk-averse environments often prefer broad-spectrum chemical pesticides because they provide visible, rapid, and predictable immediate mortality of the pest population. This clean field effect offers immediate psychological and financial reassurance, whereas the results of Integrated Pest Management can be slower. Overcoming this preference requires demonstrating long-term profitability and resilience compared to the risks of chemical failure.

155. (C) I, II, III, IV
The chronological order of plant quarantine procedures begins with a Pest Risk Analysis of the imported commodity. This is followed by the issuance of a Phytosanitary Certificate by the exporting nation. Upon arrival, the goods undergo inspection and potential fumigation at the Port of Entry. Finally, domestic post-entry quarantine observation ensures no hidden pests are introduced into the agricultural system.

156. (B) Legally restrict movement of commodities to prevent the introduction and spread of exotic pests.
National and international plant quarantine regulations function as a critical preventative Integrated Pest Management strategy. Their primary purpose is to legally restrict the movement of agricultural commodities to prevent the introduction and spread of exotic pests and pathogens. By maintaining strict standards at borders, countries can protect domestic agriculture from invasive species that could cause severe damage.

157. (A) Asian irrigated rice ecosystems.
The participatory Farmer Field School extension methodology was originally pioneered in the late 1980s in response to pest crises in Asian irrigated rice ecosystems. This experiential learning approach empowers farmers to become experts through hands-on observation and experimentation. By building local knowledge of ecology and management, FFS has been highly successful in promoting widespread adoption of sustainable practices.

158. (C) Scientifically rigorous Pest Risk Analysis (PRA) and continuous surveillance.
The enforcement of a robust phytosanitary policy relies on the continuous execution of scientifically rigorous Pest Risk Analysis and ongoing surveillance. These processes allow authorities to identify potential threats and implement appropriate regulatory measures to mitigate risk. By combining scientific data with legislative authority, a country can effectively prevent transboundary movement of pests while facilitating safe international trade in commodities.

159. (D) The International Plant Protection Convention (IPPC) sets globally recognized standards to prevent the spread of plant pests.
The International Plant Protection Convention is a critical global framework that sets recognized standards to prevent the introduction and spread of plant pests. These standards provide a common basis for national phytosanitary regulations and facilitate safe international trade. By harmonizing requirements, the IPPC helps protect global food security and biodiversity while ensuring that plant health measures remain scientifically justified.

NODIA

160. (C) Destructive Insects and Pests (DIP) Act, 1914
In India, the primary legislative backing and statutory authority for enforcing domestic and international plant quarantine regulations is the Destructive Insects and Pests Act of 1914. This landmark legislation empowers the government to prevent the introduction of any insect or fungus that may be destructive to crops. It remains the foundational legal framework for protecting national agricultural resources.

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(D) P-1, Q-4, R-3, S-2

2010

16. What defines High Volume (HV) spraying in the context of pesticide application?
(A) Applying concentrated pesticide with rotary atomizers without water or additional diluent
(B) Applying spray using thermal fogging equipment only for indoor pest control operations
(C) Applying spray liquid to thoroughly wet the foliage, often to the point of run-off
(D) Generating microscopic droplets to float in the crop canopy for extended time periods

2006

17. Which of the following statements regarding Low Volume (LV) spraying is INCORRECT?
(A) It requires highly concentrated pesticide mixtures compared to HV spraying
(B) It relies entirely on continuous heavy runoff to achieve pest control
(C) It saves time and labor by reducing the amount of water required for mixing
(D) Fine droplets are typically required to ensure adequate coverage with lower volumes

2005

18. Which of the following pairs correctly matches the application volume category with its typical equipment?
(A) High Volume (HV) - Specialized handheld rotary atomizer disc system
(B) Low Volume (LV) - Targeted soil injecting gun for root-zone treatment
(C) High Volume (HV) - Stationary cold aerosol generator for warehouse use
(D) Ultra-Low Volume (ULV) - Motorized knapsack mist blower with a restrictor

2022

19. An applicator needs to treat a massive, water-scarce agricultural area rapidly. Which volume classification and corresponding technique should be applied?
(A) Ultra-Low Volume application using aerial or specialized ULV equipment
(B) High Volume application using a pedal pump
(C) Medium Volume application using a standard knapsack sprayer
(D) High Volume application using a tractor-mounted boom sprayer

2015

20. Consider the following statements about spray drift mechanisms:
I. High relative humidity significantly increases the evaporation rate, exacerbating spray drift.
II. Droplets smaller than 50 microns in diameter are highly susceptible to wind drift.
III. Spray drift only occurs during aerial applications, never during ground applications.
IV. Increasing the application height from the target increases the potential for spray drift.
Which of the above statement(s) is/are INCORRECT?
(A) I and III
(B) I, II and IV
(C) II and IV
(D) II, III and IV

2006

21. Which meteorological factor is most directly responsible for the upward displacement and long-distance transport of fine spray droplets?
(A) Thermal convection currents (updrafts)
(B) High atmospheric pressure levels
(C) Low relative humidity conditions
(D) Continuous heavy rainfall events

2011

22. What is the primary effect of operating a boom sprayer during a strong temperature inversion?
(A) Droplets evaporate immediately upon leaving the nozzle orifice
(B) Droplets are forced forcefully into the saturated soil surface
(C) The liquid formulation chemically degrades within the spray tank
(D) Fine droplets remain suspended in clouds and move laterally off-target

2012

23. Which of the following is NOT a recognized drift reduction technology or practice?
(A) Using air-induction (venturi) nozzles
(B) Elevating the spray boom to maximum height
(C) Adding drift retardant adjuvants to the tank mix
(D) Using shielded or shrouded spray booms

2017

24. When comparing standard flat fan nozzles to air-induction (venturi) nozzles for drift control, which statement is accurate?
(A) Air-induction nozzles produce a higher

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(B) Half of the spray volume consists of droplets larger than this value and half smaller
(C) The spray consists exclusively of droplets that are of that specific diameter and size
(D) The droplet size provides the maximum retention on the target surface under ideal conditions

2005

8. A high VMD/NMD ratio in a spray application typically indicates which of the following?
(A) A highly uniform droplet size spectrum
(B) That the majority of the droplets are extremely small
(C) A wide variation in droplet sizes within the spray spectrum
(D) That drift risk is virtually eliminated

2009

9. Number Median Diameter (NMD) is primarily used to evaluate:
(A) The total liquid volume discharged per minute from the pump at a set pressure
(B) The pressure required to generate an optimal spray pattern for specific nozzles
(C) The exact size of the largest droplet produced by a nozzle during atomization
(D) The median droplet size based on the numerical count of droplets in the spray cloud

2002

10. Consider the following statements regarding droplet size parameters:
I. A VMD/NMD ratio equal to 1 represents a perfectly monodisperse spray.
II. In agricultural sprays, VMD is always smaller than NMD.
III. Rotary atomizers generally produce a lower VMD/NMD ratio than hydraulic nozzles.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I only

2015

11. When comparing VMD and NMD in a typical agricultural spray spectrum, which of the following holds true?
(A) VMD is numerically equal to NMD regardless of the nozzle type or operating pressure
(B) VMD is larger than NMD because large droplets contain most of the total volume
(C) VMD is smaller than NMD because small droplets dominate the total volume spectrum
(D) NMD is entirely dependent on liquid volume rather than the numerical droplet count

2006

12. All of the following are practical implications of measuring the VMD/NMD ratio EXCEPT:
(A) It helps in assessing the uniformity of the spray atomization
(B) It determines the exact forward speed required for the application equipment
(C) It indicates the potential risk of spray drift from the fine droplet fraction
(D) It guides the selection of appropriate atomizers for specific pest targets

2003

13. Which mathematical concept accurately describes the relationship between a droplet's diameter and its volume?
(A) Volume is proportional to the cube of the diameter
(B) Volume is directly proportional to the diameter
(C) Volume is proportional to the square of the diameter
(D) Volume is inversely proportional to the diameter

2017

14. According to standard classifications, Ultra-Low Volume (ULV) application for field crops typically involves a spray volume of:
(A) More than 400 liters per hectare
(B) Between 10 and 200 liters per hectare
(C) Less than 5 liters per hectare
(D) Exactly 50 liters per hectare

2006

15. Match the spray volume classifications (List I) with their typical application rates for field crops (List II).
List I: (Spray Volume Classification)
P. High Volume (HV)
Q. Low Volume (LV)
R. Ultra-Low Volume (ULV)
S. Medium Volume (MV)
List II: (Application Rate)
1. Less than 5 L/ha
2. 5 to 50 L/ha
3. More than 400 L/ha
4. 50 to 400 L/ha
(A) P-3, Q-2, R-1, S-4
(B) P-3, Q-1, R-2, S-4
(C) P-2, Q-3, R-1, S-4

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(A) I and II
(B) II and III
(C) I and III
(D) I only

2024

51. An applicator wants to quickly change nozzle tips in the field without using wrenches. Which specific component allows for this convenience on modern sprayers?
(A) Quick-attach (bayonet-style) cap assemblies
(B) Brass threaded caps
(C) High-pressure relief valves
(D) Diaphragm check valves

2005

52. The internal core or swirl plate is a distinct anatomical feature found specifically in which type of nozzle?
(A) Flat fan nozzle
(B) Floodjet nozzle
(C) Hollow cone nozzle
(D) Air-induction flat fan nozzle

2017

53. What defines the spray pattern of a flat fan nozzle?
(A) It emits liquid in a tapered or even sheet-like elliptical pattern
(B) It produces a circular ring of liquid with a dry center
(C) It creates a wide angle, low-pressure sheet of extremely large droplets
(D) It atomizes liquid purely through high-speed mechanical rotation

2003

54. When comparing solid (full) cone nozzles to hollow cone nozzles, solid cone nozzles typically:
(A) Produce finer droplets and are preferred for low-volume aerial applications
(B) Lack a swirl plate or internal core completely in their anatomical design
(C) Operate at much lower pressures and have a significantly wider spray angle
(D) Produce larger droplets and distribute liquid throughout the circular impact area

2007

55. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Floodjet (deflector) nozzles are frequently used for applying liquid fertilizers or soil-applied herbicides.
Reason (R): Floodjet nozzles operate at low pressures and produce a wide-angle spray pattern with large, drift-resistant droplets.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2010

56. Which type of nozzle generates droplets by directing the liquid stream through a small orifice to strike a smooth angled surface?
(A) Hollow cone nozzle
(B) Standard flat fan nozzle
(C) Floodjet (deflector) nozzle
(D) Twin-fluid atomizer

2005

57. Which of the following statements about hollow cone nozzles is INCORRECT?
(A) They produce relatively fine droplets, making them ideal for penetration into dense crop canopies
(B) They utilize an internal core or swirl plate to induce a rotational velocity to the liquid
(C) The spray pattern forms a circular ring with very little liquid in the center
(D) They are the preferred nozzle type for broadcast application of systemic herbicides on soil

2019

58. Using a standard tapered flat fan nozzle without overlapping the edges of adjacent spray patterns will result in:
(A) Uneven distribution, with lower application rates at the edges of the swath
(B) Perfectly uniform distribution across the entire boom width
(C) Excessive application rates and crop phytotoxicity at the pattern edges
(D) Spontaneous destruction of the nozzle orifice due to backpressure

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2005

59. For applying contact fungicides and insecticides to dense foliage where penetration and under-leaf coverage are critical, the most appropriate nozzle selection is:
(A) Standard flat fan nozzle
(B) Hollow cone nozzle
(C) Floodjet nozzle
(D) Solid stream nozzle

proportion of drift-prone fine droplets
(B) Standard flat fan nozzles operate at much lower pressures, inherently preventing drift
(C) Air-induction nozzles create larger, air-filled droplets that shatter on impact
(D) Air-induction nozzles cannot be used with systemic herbicides in any scenario

2004

25. Select the correct sequence of meteorological conditions from highest drift risk to lowest drift risk.
(A) Strong wind with temperature inversion → Moderate wind under stable sky → Calm wind with high humidity
(B) Calm wind with high humidity → Strong wind with temperature inversion → Moderate wind under stable sky
(C) Moderate wind under stable sky → Calm wind with high humidity → Strong wind with temperature inversion
(D) Calm wind with high humidity → Moderate wind under stable sky → Strong wind with temperature inversion

2017

26. The phenomenon where vaporized pesticide active ingredients move off-target after application is specifically termed:
(A) Vapor drift
(B) Particle drift
(C) Run-off
(D) Leaching

2007

27. The primary function of an agitator in a sprayer tank is to:
(A) Atomize the spray liquid before it reaches the nozzles
(B) Maintain uniform suspension or mixture of the pesticide formulation in the diluent
(C) Regulate the forward speed of the sprayer
(D) Filter out large debris from the liquid entering the pump

2004

28. Which of the following statements about sprayer pressure regulators is INCORRECT?
(A) They control the liquid pressure delivered to the nozzles
(B) They automatically adjust the tractor's forward speed to maintain a constant application rate
(C) They bypass excess liquid back into the spray tank
(D) They protect the pump and system components from over-pressure damage

2009

29. If a wettable powder (WP) formulation is being applied, which component is most critical to prevent the chemical from settling at the bottom of the tank?
(A) A mechanical or hydraulic agitator
(B) The pressure gauge
(C) The suction strainer
(D) The anti-drip valve

2017

30. Consider the following components of a tractor-mounted boom sprayer:
I. Pressure regulator
II. Agitator
III. Centrifugal pump
IV. Drone flight controller
V. Nozzle body
Which of the above components are found on a standard tractor-mounted boom sprayer?
(A) I, III, IV and V
(B) II, III and IV
(C) I, II, III and V
(D) I, IV and V

2013

31. Hydraulic agitation in a sprayer tank is achieved by:
(A) Using rotating mechanical paddles mounted on a central shaft inside the spray tank
(B) Shaking the tank manually during operation to maintain formulation suspension
(C) Injecting compressed air from the tractor's pneumatic brakes into the tank
(D) Routing pressurized liquid from the pump back to the tank through a specialized nozzle

2007

32. Which statement correctly describes the role of strainers in a sprayer system?
(A) They increase the discharge pressure to the nozzles
(B) They induce a negative charge on the spray droplets
(C) They prevent nozzle blockages and protect the pump from abrasive wear
(D) They accurately measure the amount of liquid remaining in the tank

2014

33. The continuous operation of a positive displacement pump with a closed discharge line will result in:

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CHAPTER 10
Pesticide Application Equipments

2024

1. Which of the following best defines droplet spread dynamics in the context of pesticide application?
(A) The physical transportation of the droplet away from the target zone due to wind currents
(B) The expansion and deformation of a droplet upon impacting and wetting the target surface
(C) The maximum pressure exerted by the hydraulic pump to atomize the liquid into droplets
(D) The rate at which the active ingredient evaporates before reaching the target surface

2002

2. The critical volume of spray liquid retained on a leaf surface before it begins to run off is primarily influenced by which of the following?
(A) The forward speed of the tractor
(B) The total capacity of the sprayer tank
(C) The operating pressure of the pressure relief valve
(D) The surface tension of the spray liquid and leaf topography

2023

3. If an applicator increases the spray operating pressure significantly without changing the nozzle tip, what is the most likely outcome regarding target coverage?
(A) Droplet size decreases, potentially improving coverage but increasing drift risk
(B) Droplet size increases, improving retention but decreasing coverage uniformity
(C) Target coverage remains unchanged because the discharge rate compensates
(D) Droplet spread dynamics are completely halted upon impact

2024

4. Which of the following statements regarding the basic principles of pesticide application is an EXCEPTION to ideal target coverage?
(A) Achieving uniform distribution of droplets across the target surface improves pest control
(B) Smaller droplets generally provide better coverage density per unit volume of liquid
(C) Applying spray liquid until continuous heavy runoff occurs ensures maximum biological efficacy
(D) Droplet retention is highly dependent on the formulation properties of the pesticide

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2025

5. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The addition of a surfactant to a pesticide formulation generally increases the retention of droplets on waxy leaf surfaces.
Reason (R): Surfactants increase the surface tension of the liquid, preventing droplets from spreading out and evaporating quickly.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2001

6. Which of the following statements correctly identifies the relationship between droplet size and target coverage?
(A) Larger droplets provide a significantly higher number of droplets per unit area for the same volume
(B) Halving the droplet diameter reduces the total number of droplets by a factor of four in the cloud
(C) Target coverage is fundamentally independent of droplet size if the application volume is high enough
(D) Halving the droplet diameter increases their total number eightfold for a given spray volume

2024

7. The Volume Median Diameter (VMD) of a spray is defined as the droplet diameter where:
(A) Half of the total number of droplets are larger and half are smaller in the cloud

pressure in PSI)
(D) (Swath width in meters × Forward speed in km/h)

2015

42. If a tractor operator halves the forward speed while maintaining the same nozzle discharge rate and swath width, the application volume per hectare will:
(A) Double
(B) Decrease by half
(C) Remain unchanged
(D) Increase by 50 percent

2018

43. Swath width for a broadcast boom sprayer is defined as:
(A) The physical length of the tractor
(B) The number of nozzles multiplied by the distance between adjacent nozzles
(C) The height of the boom above the crop canopy
(D) The distance between the front and rear wheels of the tractor

2002

44. During sprayer calibration, all of the following parameters must be strictly measured EXCEPT:
(A) The actual forward speed of the tractor in the field
(B) The relative humidity of the surrounding air
(C) The liquid discharge rate from the nozzles
(D) The nozzle spacing or effective swath width

2001

45. Consider the following standard steps for calibrating a tractor-mounted boom sprayer:
I. Determine the application volume delivered per hectare based on calculations
II. Measure the effective swath width of the boom
III. Measure the actual forward speed of the tractor in field conditions
IV. Measure the nozzle discharge rate by collecting water for a set time at operating pressure
Which of the following represents the correct sequence of operations?
(A) II → III → IV → I
(B) IV → I → III → II
(C) I → II → IV → III
(D) III → II → I → IV

2025

46. If a single nozzle on a boom is discharging significantly less liquid than the others during calibration, the most appropriate immediate action is to:
(A) Increase the tractor forward speed
(B) Increase the main pressure regulator setting
(C) Clean or replace the faulty nozzle tip and strainer
(D) Add more surfactant to the tank

2005

47. Which of the following statements about the anatomy of a standard hydraulic nozzle is INCORRECT?
(A) The nozzle body holds the internal components and attaches to the boom
(B) The strainer filters out particles that could clog the nozzle orifice
(C) The nozzle tip is the primary component that dictates the spray pattern and flow rate
(D) The cap assembly connects the nozzle directly to the tractor's PTO shaft

2011

48. Identify the correct pair regarding nozzle components and their functions.
(A) Nozzle body - Controls the forward speed of the sprayer
(B) Cap assembly - Filters abrasive materials from the liquid
(C) Nozzle tip - Determines the atomization pattern and discharge capacity
(D) Strainer - Regulates the system's overall hydraulic pressure

2019

49. The material composition of a nozzle tip primarily affects:
(A) The biological efficacy of the pesticide active ingredient
(B) Its resistance to physical wear and chemical corrosion over time
(C) The exact VMD required to eliminate a specific insect species
(D) The rotational speed of the hydraulic pump

2016

50. Consider the following statements about nozzle strainers:
I. They are typically color-coded to match the tractor brand.
II. Check valves can be integrated into strainers to prevent dripping when pressure drops.
III. They are graded by mesh size, with higher numbers indicating finer screens.
Which of the above statement(s) is/are INCORRECT?

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2021

69. A steady decline in spray pressure and swath width during the operation of a pneumatic compression sprayer is primarily caused by:
(A) The expansion of air space as liquid is depleted, lowering the internal pressure
(B) The chemical breakdown of the pesticide formulation within the tank
(C) Rapid physical wear of the brass nozzle tip during pressurized emission
(D) The continuous operation of the pump handle by the human operator

2019

70. Select the correct sequence of operations for properly utilizing a pneumatic (compression) sprayer.
(A) Fill tank with mixture → Seal tank tightly → Pump air to desired pressure → Open trigger valve to spray
(B) Pump air to desired pressure → Fill tank with mixture → Seal tank tightly → Open trigger valve to spray
(C) Open trigger valve to spray → Fill tank with mixture → Seal tank tightly → Pump air to desired pressure
(D) Fill tank with mixture → Open trigger valve to spray → Seal tank tightly → Pump air to desired pressure

2011

71. The pump assembly in a standard lever-operated knapsack sprayer is usually located:
(A) Outside the tank, driven by the operator's foot
(B) Inside or adjacent to the tank, operated by a hand lever
(C) Attached to the boom, independent of the tank
(D) Inside the nozzle body

2006

72. Which of the following is NOT a feature of a motorized knapsack mist blower?
(A) It utilizes a small 2-stroke petrol engine
(B) It can atomize liquids into relatively fine droplets
(C) It functions exclusively as a High Volume (HV) hydraulic sprayer
(D) It directs spray into the canopy using a high-velocity air stream

2011

73. When comparing a tractor-mounted boom sprayer to an orchard air-blast sprayer:
(A) The boom sprayer relies on air velocity while the air-blast relies on hydraulic pressure
(B) The air-blast sprayer is primarily used for low-growing field crops like soybeans
(C) The boom sprayer cannot be fitted with flat fan nozzles for broadcast applications
(D) The air-blast sprayer uses forced air to propel droplets into tree canopies

2022

74. The primary mechanism of atomization in a standard motorized knapsack mist blower is:
(A) Shearing of the liquid fed into a high-velocity air stream generated by a centrifugal fan
(B) Hydraulic pressure generated by a plunger pump pushing liquid through a very fine orifice
(C) Thermal vaporization using a heated exhaust pipe
(D) Ultrasonic vibrations generated by a piezo-electric transducer

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2001

75. Consider the following operational characteristics of orchard air-blast sprayers:
I. They can achieve excellent penetration into dense tree canopies.
II. They operate completely independently of the tractor's Power Take-Off (PTO).
III. They are known for having very low drift potential under all wind conditions.
IV. They combine hydraulic nozzles with a large volume of forced air.
Which of the above statement(s) is/are INCORRECT?
(A) I and IV
(B) I, II and IV
(C) II and III
(D) III and IV

2014

76. What defines the operation of a trailing edge boom on a tractor-mounted sprayer?
(A) The boom is mounted vertically to spray orchard trees
(B) The boom is attached to the rear of the tractor and oriented horizontally across the crop
(C) The boom consists entirely of air-shear nozzles
(D) The boom rotates on a central axis to cover a circular area

2014

77. Which of the following statements about tractor-mounted boom sprayers is INCORRECT?

2008

60. Consider the following criteria for selecting a standard flat fan nozzle:
I. Used primarily for broadcast herbicide applications.
II. Requires a specific overlap (usually 30-50%) to achieve uniform distribution.
III. Generates massive droplets to prevent drift at pressures above 100 PSI.
IV. The spray angle determines the optimal boom height.
Which of the above statement(s) is/are correct?
(A) I, II, III and IV
(B) II and III
(C) I, II and IV
(D) I and III

2010

61. For applying systemic herbicides in a post-emergence broadcast application with minimal drift risk, which nozzle is typically recommended?
(A) Air-induction flat fan or standard flat fan at low pressure
(B) Fine-droplet hollow cone
(C) Rotary atomizer spinning at 10,000 RPM
(D) High-pressure solid cone

2008

62. The standard color-coding system (e.g., ISO standard) on modern agricultural nozzles is used to indicate the nozzle's:
(A) Chemical resistance
(B) Required operating pressure
(C) Discharge flow rate at a standard pressure
(D) Manufacturing brand

2023

63. All of the following are appropriate selection criteria for minimizing spray drift near sensitive crops EXCEPT:
(A) Selecting air-induction (venturi) nozzles
(B) Selecting nozzles with larger orifice sizes
(C) Selecting nozzles designed to operate at lower pressures
(D) Selecting nozzles that produce a VMD of 100 microns or less

2013

64. Which statement represents the best practice for band spraying herbicides over crop rows?
(A) Tapered flat fan nozzles should be used without overlap to create the band
(B) Even flat fan nozzles should be selected to apply a uniform dose across the entire band width
(C) Solid stream nozzles are the only acceptable choice for band applications
(D) Hollow cone nozzles must be used to ensure soil penetration

2010

65. Match the specific pesticide application scenario (List I) with the most appropriate nozzle type (List II).
List I: (Application Scenario)
P. Broadcast systemic herbicide
Q. Fungicide penetration in dense canopy
R. Liquid fertilizer application with minimal drift
S. Uniform band application over a crop row
List II: (Nozzle Type)
1. Floodjet (deflector) nozzle
2. Even flat fan nozzle
3. Standard or air-induction flat fan nozzle
4. Hollow cone nozzle
(A) P-2, Q-3, R-1, S-4
(B) P-3, Q-4, R-1, S-2
(C) P-3, Q-1, R-4, S-2
(D) P-1, Q-4, R-3, S-2

2011

66. The typical tank capacity of a manually operated knapsack sprayer designed to be carried on an operator's back is:
(A) 1 to 3 liters
(B) 50 to 100 liters
(C) 200 to 400 liters
(D) 10 to 20 liters

2002

67. The defining feature of a pneumatic (compression) sprayer is that:
(A) Air is pumped into the sealed tank above the liquid to create the spraying pressure
(B) The pump forces spray liquid directly to the nozzle with each stroke
(C) It relies on an internal combustion engine to generate air blast
(D) It requires continuous pumping by the operator's foot during spraying

2017

68. An operator needs to spray tall fruit trees in a small orchard but has no access to motorized equipment. Which manual sprayer is most appropriate?
(A) Small hand-held trigger sprayer
(B) Pneumatic compression sprayer with a 5-liter tank
(C) Foot (pedal) sprayer or rocking sprayer
(D) Hand rotary duster

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(A) Improved atomization at the nozzles
(B) Severe damage to the pump or bursting of hoses if a relief valve is not present
(C) Automatic shut-off of the tractor engine
(D) Enhanced hydraulic agitation in the main tank

2014

34. All of the following are classified as positive displacement pumps EXCEPT:
(A) Plunger pump
(B) Diaphragm pump
(C) Gear pump
(D) Centrifugal pump

2001

35. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Diaphragm pumps are highly suitable for pumping abrasive wettable powder suspensions.
Reason (R): In a diaphragm pump, the moving mechanical parts are separated from the spray liquid by a flexible barrier.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2022

36. When comparing roller pumps to plunger pumps, which of the following is accurate?
(A) Roller pumps generally produce much higher maximum pressures than plunger pumps
(B) Plunger pumps wear out extremely fast when pumping clean liquids compared to roller pumps
(C) Roller pumps are more susceptible to wear from abrasive materials than plunger pumps
(D) Plunger pumps are strictly used for ultra-low volume aerial applications

2014

37. Which of the following defines the operational mechanism of a gear pump?
(A) It traps liquid between teeth of rotating, meshing gears and forces it to the outlet
(B) It relies on a flexible synthetic rubber diaphragm pulsating back and forth rapidly
(C) It uses high-speed centrifugal force to throw liquid outward from a central impeller
(D) It moves liquid through reciprocating pistons inside cylinders at very high pressures

2021

38. A plunger pump is best described as:
(A) A high-volume, low-pressure pump commonly used in small manual knapsack sprayers
(B) A non-positive displacement pump that fails to operate under high system resistance
(C) A pump that uses a rotary impeller to create a vacuum for liquid suction operations
(D) A positive displacement pump generating high pressures, ideal for orchard sprayers

2022

39. Which pump type would be the most economically and operationally appropriate for a standard low-pressure tractor boom sprayer applying non-abrasive herbicide emulsions?
(A) High-pressure triplex plunger pump
(B) Roller vane pump
(C) Centrifugal pump operating at 1000 PSI
(D) Cold aerosol generator pump

2012

40. Match the sprayer calibration variables (List I) with their direct effect or definition (List II).
List I: (Calibration Variable)
P. Swath width
Q. Forward speed
R. Discharge rate
S. Application volume
List II: (Effect or Definition)
1. The amount of liquid applied per unit area (e.g., L/ha)
2. The total width treated during one pass of the sprayer
3. The volume of liquid emitted per minute from the nozzles
4. The velocity at which the equipment travels over the field
(A) P-2, Q-4, R-1, S-3
(B) P-3, Q-1, R-4, S-2
(C) P-2, Q-4, R-3, S-1
(D) P-4, Q-2, R-1, S-3

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2018

41. The formula to calculate application volume (L/ha) for a boom sprayer is given by (600 × total discharge in L/min) divided by:
(A) (Tank capacity in liters × Forward speed in km/h)
(B) (Operating pressure in PSI × Nozzle spacing in cm)
(C) (Swath width in meters × Operating

(A) The boom height is fixed and cannot be adjusted for different crop stages
(B) The pump is typically driven by the tractor's PTO
(C) They are primarily designed for uniform broadcast spraying of field crops
(D) They usually incorporate a pressure regulator, agitator, and strainers

2017

78. A motorized knapsack mist blower can often be converted to apply dry formulations by:
(A) Removing the engine and operating it manually
(B) Adding a thermal heating element to the nozzle tube
(C) Changing the liquid tank to a hopper and installing a dusting attachment
(D) Replacing the centrifugal fan with a high-pressure diaphragm pump

2010

79. The fundamental operating principle of a duster is to:
(A) Dissolve dry powder in water immediately prior to application
(B) Atomize liquid pesticide into solid dust particles through rapid cooling
(C) Bury dry granules directly into the soil using a furrow opener
(D) Suspend dry pesticide particles in a forced air stream for delivery to the target

2004

80. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Dust formulations generally exhibit a higher drift potential compared to typical agricultural liquid sprays.
Reason (R): Dust particles are exceedingly fine and lightweight, and lack the moisture weight needed to settle rapidly.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2024

81. What defines a hand rotary duster?
(A) A piece of equipment that thermalizes dust to form smoke
(B) A manually operated machine using a hand crank to drive a fan that blows dust from a hopper
(C) A large tractor-drawn machine for massive field application
(D) A stationary device that uses an electric fan to dispense dust in greenhouses

2021

82. Which environmental condition is considered most advantageous for the effective retention of pesticide dusts on foliage?
(A) High wind speeds and dry foliage
(B) High temperatures and bright sunlight
(C) Heavy continuous rainfall during application
(D) The presence of daily dew on the leaf surface early in the morning

2004

83. Identify the correct pair regarding dusting equipment and its application scale.
(A) Hand rotary duster - Small to medium scale field crops or specific pest spots
(B) Plunger duster - Large scale commercial fruit orchards
(C) Tractor-mounted power duster - Small kitchen gardens
(D) Motorized knapsack duster - Enclosed grain silos only

2010

84. The feeding mechanism in a power duster ensures that:
(A) Water is mixed with the dust at the exact moment of emission
(B) The dust particles are electrically charged for better adhesion
(C) A continuous and regulated amount of dust drops into the air stream
(D) Dust is compacted into solid granules before application

2023

85. Match the fogging equipment (List I) with its core operational principle (List II).
List I: (Fogging Equipment)
P. Thermal fogger
Q. Cold aerosol generator (ULV fogger)
R. Plunger duster
S. Knapsack sprayer
List II: (Operational Principle)
1. Uses mechanical shearing or air vortices to atomize liquid without heat
2. Injects pesticide oil solution into a hot exhaust gas stream
3. Pushes dry powder through a tube using a

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for regulatory record-keeping
(D) It enables integration with variable rate application technology

2023

157. The term "precision spraying" using drone technology is best defined as:
(A) Utilizing spatial data to apply agrochemicals only where needed, at the exact required dose
(B) Applying a constant, maximum volume of chemical across an entire region
(C) Spraying exclusively at perfectly round altitudes
(D) Operating multiple drones simultaneously without any central controller

2023

158. The downward thrust (rotor wash) of a multi-rotor agricultural drone can directly result in:
(A) Increased evaporation of the active ingredient
(B) Instant freezing of the spray lines
(C) Improved canopy penetration and under-leaf coverage of the spray droplets
(D) Total elimination of the need for liquid carriers

2018

159. Which is a recognized limitation of current electric multi-rotor agricultural spray drones?
(A) Inability to hover over a specific pest hotspot
(B) Their inability to be equipped with GPS and automated flight controllers
(C) The requirement for a mile-long paved runway
(D) Very limited battery life and small payload capacities compared to manned aircraft

2012

160. The integration of multispectral imaging with drone application allows for:
(A) The drone to charge its batteries using sunlight during flight
(B) The creation of prescription maps, enabling targeted spot-sprating of infested areas
(C) The chemical to be synthesized inside the drone tank mid-flight
(D) Visualizing underground water tables to adjust flight altitude

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room temperature
(C) Many active ingredients are thermally unstable and degrade completely upon ignition
(D) The active ingredient must be a biological agent (like beneficial nematodes)

2009

95. Consider the following statements about smoke generators:
I. They require no external power source or complex machinery to operate.
II. The smoke acts as a space treatment rather than a targeted surface residual treatment.
III. They are generally safe to handle with bare hands immediately after ignition.
Which of the above statement(s) is/are correct?
(A) I, II and III
(B) II and III
(C) I and III
(D) I and II

2023

96. Safety protocols for deploying a smoke generator in a greenhouse mandate that:
(A) Windows should be kept open to ensure adequate ventilation during generation
(B) Operators must remain inside without respirators to monitor the smoke spread
(C) The generator must be placed on a heat-resistant surface and the area evacuated immediately after ignition
(D) The greenhouse should be extensively flooded with water immediately before ignition

2007

97. The application of volatile liquid fumigants into the soil for nematode control typically requires:
(A) A thermal fogging machine
(B) A soil injecting gun or a tractor-mounted shank injector
(C) A standard knapsack sprayer fitted with a flat fan nozzle
(D) A dry seed treating drum

2009

98. Which of the following statements about soil granular applicators is INCORRECT?
(A) They are designed to meter out dry, uniform granules at a specific rate
(B) They typically place granules in a band over the row or directly into the seed furrow
(C) Gravity or a forced air stream is often used to deliver granules from the hopper to the soil
(D) They require high-pressure hydraulic pumps to force the granules into the soil

2013

99. The defining function of a soil injecting gun is to:
(A) Deliver a measured dose of liquid pesticide beneath the soil surface near plant roots
(B) Spray liquid herbicides uniformly across the soil surface
(C) Incorporate dry dusts onto the topsoil layer
(D) Heat the soil to sterilize weed seeds

2005

100. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Soil fumigation requires sealing the soil surface immediately after application.
Reason (R): Fumigants act in the gaseous phase and will rapidly escape into the atmosphere if the soil is not tarped or compacted.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2004

101. Which component is critical in a tractor-mounted shank injector to ensure precise delivery of soil fumigants?
(A) The positive displacement metering pump or orifice plate
(B) The centrifugal fan
(C) The rotary atomizer disc
(D) The pyrotechnic igniter

2005

102. When comparing the application of soil fumigants to soil granular nematicides:
(A) Granules require specialized pressurized tanks, while fumigants can be applied by hand
(B) Fumigants are primarily active against foliar insects, whereas granules target only soil fungi
(C) Granules evaporate immediately upon soil contact, requiring high pressure injection
(D) Fumigants require specialized injection and sealing, while granules use gravity hoppers

NODIA

2002

103. The primary concept behind using a slurry seed treater rather than a dry seed treating drum is to:

2023

139. What is the effect of adjusting the blade pitch on a wind-driven rotary atomizer (Micronair)?
(A) It changes the orientation of the boom
(B) It changes the rotational speed of the atomizer cage, thereby adjusting the droplet size
(C) It adjusts the chemical concentration of the tank mix
(D) It alters the application height of the aircraft

2003

140. Which statement best describes a trailing edge boom system on a fixed-wing aircraft?
(A) Mounted vertically on the tail fin to provide coverage for tall-standing agricultural targets
(B) Behind the wing's trailing edge to position nozzles in smooth airflow, reducing drag and turbulence
(C) Trailings hundreds of feet behind the aircraft on a high-tensile tow cable for deep canopy penetration
(D) Specifically designed to dump the entire tank load instantly during a critical flight safety emergency

2004

141. A check valve (anti-drip valve) on an aerial spray boom nozzle is defined as a component that:
(A) Prevents the nozzle from dripping liquid during turns or when the main spray valve is shut off
(B) Constantly monitors the chemical concentration
(C) Increases the operating pressure to 500 PSI
(D) Prevents wind from entering the spray lines

2013

142. If an aerial application is conducted during a severe temperature inversion, what happens to the spray cloud?
(A) It is immediately pulled into the upper atmosphere and disperses safely
(B) It freezes instantly into solid particles
(C) It becomes trapped in a cool layer of air near the ground and can drift laterally for miles
(D) It evaporates completely before reaching the canopy

2022

143. Comparing the effects of high and low relative humidity on aerial spraying:
(A) Low humidity decreases evaporation rates compared to high humidity environments
(B) High humidity causes water-based droplets to shatter upon leaving the spray nozzle
(C) Relative humidity only affects oil-based ULV formulations in arid climate zones
(D) Low humidity increases evaporation of water-based droplets, increasing drift risk

2005

144. Wind speed is a critical meteorological factor in aerial application. What is the generally recommended optimal wind speed range for effective and safe aerial spraying?
(A) 0 to 2 km/h (Dead calm)
(B) 4 to 15 km/h
(C) 25 to 40 km/h
(D) Greater than 50 km/h

2017

145. Which of the following statements about meteorological factors affecting aerial application is INCORRECT?
(A) High temperatures can increase the volatility of certain herbicides
(B) Spraying during dead calm conditions is ideal because drift risk is entirely eliminated
(C) Crosswinds can be utilized constructively to overlap spray swaths effectively
(D) Updrafts and thermal convection during the heat of the day can carry fine droplets off target

2022

146. The concept of "delta T" (wet bulb depression) in aerial spraying is used to assess:
(A) The necessary angle of attack for the aircraft wings
(B) The hydraulic pressure differential across the pump
(C) The rate of chemical breakdown in the tank
(D) The evaporation potential of spray droplets and optimal spraying conditions

2022

147. All of the following meteorological parameters should routinely trigger an immediate halt to aerial herbicide application EXCEPT:
(A) Consistent light breeze of 8 km/h blowing away from sensitive areas
(B) Approaching severe thunderstorms with erratic gust fronts
(C) Presence of dense ground fog indicating an inversion
(D) Wind speeds exceeding 30 km/h

2009

148. A major operational advantage of aerial pesticide application is its ability to:

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2007

111. Which statement concerning the principles of thermal weed control using flame throwers is INCORRECT?
(A) The objective is not to burn the weed to ashes, but to rupture plant cells through a rapid temperature spike
(B) It is a non-chemical method often used in organic farming systems
(C) Young, broadleaf weeds are generally more susceptible than mature grasses
(D) It provides long-lasting residual control of weed seeds deep within the soil profile

2023

112. Comparing flame throwers to conventional herbicide applications, a distinct advantage of the flame thrower is that:
(A) It can operate efficiently in highly dry, fire-prone environments without risk
(B) It permanently destroys the root systems of deep-rooted perennial weeds in a single pass
(C) It leaves no chemical residues in the soil or crop
(D) It requires significantly less energy consumption per hectare

2002

113. The fuel most commonly used in modern agricultural flame throwers and thermal weed control implements is:
(A) Solid coal
(B) Liquefied Petroleum Gas (LPG) or Propane
(C) Unrefined crude oil
(D) Wood pellets

2013

114. Applying a flame thrower too slowly over a mature crop canopy during weed control will likely result in:
(A) Enhanced crop growth due to thermal stimulation
(B) Reduced fuel consumption
(C) Improved root nodulation
(D) Severe phytotoxicity or destruction of the desired crop

2015

115. Consider the following regarding the operational safety of thermal pest equipment:
I. Equipment must be checked for gas leaks using soapy water, never an open flame.
II. Operating near dry, highly combustible crop residues poses a severe fire hazard.
III. Shielded burners can help protect the crop rows from heat damage.
IV. Thermal equipment can be safely used to apply flammable chemical pesticides.
V. Fuel tanks must be protected from extreme direct heat.
Which of the above statement(s) is/are correct?
(A) I, II, III and V
(B) II, III and IV
(C) I, III, IV and V
(D) I, II and IV

2017

116. "Triple rinsing" in the context of sprayer maintenance is best defined as:
(A) Rinsing the external surfaces of the sprayer three times before entering the field
(B) Flushing the tractor radiator fluid three times a year
(C) A systematic process of washing out empty pesticide containers three times to ensure maximum removal of residues
(D) Applying water to the field three times after a pesticide application

2019

117. All of the following are recommended practices for nozzle cleaning EXCEPT:
(A) Using a metal wire or pin to aggressively clear out the nozzle orifice
(B) Using a soft-bristled toothbrush to remove internal debris
(C) Soaking clogged nozzles in a mild detergent or specialized solvent
(D) Clearing blockages by blowing compressed air through the tip

2013

118. Which of the following statements about winterization of spray equipment is correct?
(A) Leaving the pump full of water prevents the seals from drying out in freezing temperatures
(B) Herbicides should be stored inside the sprayer tank throughout the winter for convenience
(C) Metal nozzles should be coated with acid to prevent rust
(D) Anti-freeze solution should be circulated through the pump and boom lines to prevent freeze damage

2015

119. To prevent abrasive wear and ensure the longevity of a plunger pump, routine maintenance must include:
(A) Bypassing the suction strainer to increase fluid intake

NODIA

simple piston pump
4. Uses hydraulic pressure to force liquid through a nozzle

(A) P-2, Q-1, R-3, S-4
(B) P-1, Q-2, R-4, S-3
(C) P-2, Q-4, R-1, S-3
(D) P-3, Q-1, R-2, S-4

2005

86. Which application environment is most suited for thermal fogging operations?
(A) Broadcast herbicide application in windy open fields
(B) Granular fertilizer application
(C) Soil fumigation for nematode control
(D) Adulticiding for mosquito control in residential or semi-enclosed spaces

2011

87. Which of the following statements concerning cold aerosol generators (ULV foggers) is INCORRECT?
(A) They produce very fine droplets, typically in the range of 5 to 50 microns
(B) They degrade heat-sensitive active ingredients significantly during atomization
(C) They are frequently used for indoor pest control and public health applications
(D) They rely on a high-velocity air stream or rotary atomizers rather than heat

2013

88. When comparing thermal foggers to cold foggers:
(A) Thermal foggers only work with water-based formulations, while cold foggers only use oil
(B) Cold foggers produce a highly visible, dense white cloud compared to thermal foggers
(C) Thermal foggers use heat vaporization, while cold foggers use mechanical atomization
(D) Thermal foggers are exclusively tractor-mounted, whereas cold foggers are always handheld

2019

89. The formulation used in thermal fog generators is typically mixed with:
(A) Pure distilled water
(B) A heavy granular inert carrier
(C) Dry talc powder
(D) A volatile oil carrier, such as diesel or kerosene

2018

90. Consider the following sequence of droplet generation in a typical pulse-jet thermal fogger:
I. Vaporized mixture exits the resonator pipe and contacts cooler ambient air
II. The rapid cooling causes the vapor to condense into microscopic fog droplets
III. Pesticide solution is injected into the hot exhaust gases in the resonator pipe
IV. The active ingredient and oil carrier are instantly vaporized by high temperatures

Which of the following represents the correct sequence?
(A) I → II → III → IV
(B) III → IV → I → II
(C) IV → III → II → I
(D) III → I → IV → II

2004

91. The primary mechanism defining a smoke generator involves:
(A) Pumping compressed air through a liquid formulation to produce foam
(B) Igniting a pyrotechnic mixture integrated with the active ingredient to produce toxic smoke
(C) Boiling water in a sealed tank to generate steam mixed with pesticide
(D) Dropping pesticide granules onto a spinning heated disk

2025

92. Which of the following is an EXCEPTION to the appropriate use of smoke generators?
(A) Treating enclosed greenhouses for aphids
(B) Treating vast open agricultural fields for weed control
(C) Fumigating grain storage bins
(D) Disinfesting empty transport containers

2019

93. A major limitation of using smoke generators in poorly sealed enclosed spaces is that:
(A) The smoke can easily escape through gaps, leading to sub-lethal dosing and reduced efficacy
(B) The smoke particles are too heavy and sink immediately to the floor
(C) The pyrotechnic reaction generates massive amounts of water that floods the space
(D) They require large diesel engines to operate

2024

94. Why must specific pesticide active ingredients be carefully selected before being formulated into smoke generators?
(A) Active ingredients must be water-soluble to ignite properly
(B) Most active ingredients naturally freeze at

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2007

129. The concept of "wake vortices" in aerial pesticide application refers to:
(A) The hydraulic turbulence inside the aircraft's spray tank
(B) The spiraling air masses trailing from the wingtips or rotor tips that can displace spray droplets
(C) The centrifugal force generated by rotary atomizers
(D) The thermal up-drafts generated by hot bare soil

2018

130. Comparing fixed-wing aircraft to helicopters for aerial application, helicopters generally:
(A) Have higher payload capacities and faster ferry speeds
(B) Produce zero wake turbulence
(C) Are significantly cheaper to operate per flight hour
(D) Have superior maneuverability and can treat smaller, irregularly shaped fields more effectively

2008

131. In aerial application aerodynamics, how does the application height directly impact the spray swath?
(A) Increasing the height generally widens the swath but significantly increases the risk of off-target drift
(B) Lowering the aircraft height continuously increases the effective swath width
(C) Increasing the height eliminates wake vortices entirely
(D) Application height has no aerodynamic effect on droplet trajectory

2021

132. Applying pesticide from an aircraft flying extremely low (e.g., within ground effect) can result in:
(A) Maximum vapor drift
(B) Increased payload capacity
(C) Poor spray distribution due to the spray cloud bouncing off the crop or soil surface
(D) Complete evaporation of the spray droplets

2005

133. Which parameter best defines the effective swath width of an agricultural aircraft?
(A) The cross-track distance between successive flight lines that provides a uniform spray deposit
(B) The exact physical wingspan of the aircraft
(C) The total length of the spray boom
(D) The altitude of the aircraft during spraying

2007

134. Which of the following statements about the aerodynamics of aerial spraying is INCORRECT?
(A) Propeller slipstream affects the distribution pattern, often shifting spray toward one side
(B) Wingtip vortices tend to entrap fine droplets and carry them upward and outward
(C) Mounting nozzles away from the extreme ends of the wings helps reduce vortex entrainment
(D) Aircraft speed has no effect on atomization when using standard hydraulic nozzles

2019

135. Rotary atomizers (e.g., Micronairs) on agricultural aircraft are primarily used to:
(A) Pump liquid from the tank to the boom
(B) Produce a very narrow droplet size spectrum (low VMD/NMD ratio) for ULV applications
(C) Navigate the aircraft using GPS telemetry
(D) Generate thermal fog from the aircraft exhaust

2022

136. Which equipment modification is commonly used to control spray flow automatically based on aircraft ground speed?
(A) A simple manual ball valve
(B) A fixed-pressure mechanical relief valve
(C) An electronic flow control system linked to the aircraft's GPS
(D) A gravity-fed hopper mechanism

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2025

137. All of the following are standard specialized components for aerial spray equipment EXCEPT:
(A) Wind-driven centrifugal pumps
(B) Trailing edge boom assemblies
(C) Rotary atomizers (Micronairs)
(D) Tractor PTO shafts

2006

138. The primary operating principle of a wind-driven pump on an agricultural aircraft is:
(A) Utilizing the relative airflow (slipstream) past the aircraft to turn a propeller connected to the pump shaft
(B) Utilizing an electric motor powered by the aircraft battery
(C) Harnessing exhaust gases from the engine to drive a turbine
(D) Relying entirely on gravity to pressurize the boom

(A) Completely dissolve the seed coat for faster germination
(B) Ensure the pesticide adheres securely to the seed coat using a water-based suspension, reducing dust-off
(C) Sterilize the seeds using high-pressure steam
(D) Crush the seeds slightly to allow pesticide penetration

2012

104. What is a direct negative consequence of improper operation of a dry seed treating drum that results in excess loose toxic dust?
(A) The seeds will germinate inside the drum
(B) The hydraulic pump will inevitably cavitate
(C) Increased occupational exposure risks to the operator and environmental contamination
(D) The crop will suffer from severe weed competition

2003

105. Consider the following statements about automated seed coaters:
I. They apply a highly uniform layer of pesticide and protective polymers.
II. They operate exclusively manually without electrical power.
III. They are capable of treating massive commercial volumes of seed continuously.
IV. They eliminate all needs for operator PPE.
Which of the above statement(s) is/are INCORRECT?
(A) I and III
(B) II and IV
(C) I, II and III
(D) I and IV

2011

106. All of the following are primary functions of modern seed treatment appliances EXCEPT:
(A) Applying foliar fertilizers to mature crops
(B) Coating seeds uniformly with fungicides
(C) Inoculating legume seeds with beneficial rhizobia
(D) Applying protective insecticides to prevent early-season seedling damage

2003

107. In a continuous flow slurry treater, the accurate proportioning of seed to chemical is typically controlled by:
(A) The operator manually pouring liquid every ten minutes into the mixing chamber
(B) Synchronized metering systems that link seed weight flow to the liquid discharge pump
(C) The ambient humidity sensors inside the hopper during the treatment process
(D) The speed of the tractor pulling the treater across the farm facility

2025

108. Which defines the mechanism of a simple dry seed treating drum?
(A) Seeds and chemical dust are mixed by intense hydraulic pressure
(B) Seeds and dry chemical are rotated inside a sealed baffle-equipped barrel until uniformly mixed
(C) Seeds are passed through an electrostatic field to attract dust
(D) Dry chemical is thermally vaporized over stationary seeds

2023

109. If a farmer notices severe pesticide flaking off the treated seeds during transport, the most appropriate adjustment to the seed treatment process is to:
(A) Use a slurry treater or add binding polymers instead of relying strictly on dry application
(B) Increase the tractor speed
(C) Raise the operating pressure of the field boom sprayer
(D) Substitute the seed batch with smaller sized seeds

2025

110. Match the thermal control equipment (List I) with its operational use or characteristic (List II).
List I: (Thermal Control Equipment)
P. Flame thrower
Q. Steam sterilizer
R. Infrared weed heater
S. Hot water applicator
List II: (Use or Characteristic)
1. Destroys weed tissues through high-intensity radiant heat without open flame
2. Projects a localized open fire blast to sear weeds or pests
3. Applies boiling liquid to control weeds in municipal or sensitive areas
4. Injects high-temperature vapor to eliminate soil-borne pathogens
(A) P-1, Q-4, R-2, S-3
(B) P-3, Q-1, R-4, S-2
(C) P-2, Q-4, R-1, S-3
(D) P-4, Q-2, R-3, S-1

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(A) Eliminate the need for calibration
(B) Provide 100% spray coverage on the undersides of dense lower canopy leaves
(C) Treat thousands of hectares rapidly, especially when ground conditions are too wet for tractors
(D) Function completely independently of meteorological conditions

2001

149. The economic limitation of aerial application primarily relates to:
(A) The extremely high purchase, maintenance, and insurance costs of aviation equipment and pilots
(B) The low cost of aircraft fuel
(C) The inability to use water as a carrier
(D) The requirement for excessive amounts of manual labor to flag swaths

2014

150. Identify the correct pair regarding advantages and disadvantages of aerial application.
(A) Advantage - Perfect elimination of all spray drift
(B) Disadvantage - Causes severe soil compaction and crop mechanical damage
(C) Disadvantage - Unusually slow application speed compared to manual knapsack spraying
(D) Advantage - Does not cause mechanical damage to tall or mature crops

2011

151. Which of the following represents a significant environmental disadvantage of aerial pesticide application?
(A) It requires the destruction of crop rows to allow aircraft landing
(B) It inherently possesses a higher risk of large-scale off-target drift compared to ground rigs
(C) It creates deep tire ruts that lead to soil erosion
(D) It forces the use of highly persistent organochlorine pesticides exclusively

2004

152. Under which scenario is aerial application most economically and operationally justified?
(A) A localized aphid infestation in a half-hectare enclosed greenhouse
(B) Routine weed control in a small, mixed-crop residential garden
(C) An outbreak of locusts over vast, inaccessible rangelands
(D) Applying granular fertilizer to a 1-acre plot surrounded by schools

2010

153. When comparing the timeliness of aerial vs. ground application for a rapidly spreading epidemic like soybean rust:
(A) Ground application is faster due to higher road speeds between different field sites
(B) Both methods take precisely the same amount of time per hundred hectares of coverage
(C) Aerial application is slower due to constant runway refueling and reloading delays
(D) Aerial application can deploy fungicides much faster over large acreages before damage

2001

154. The fundamental reason why aerial application struggles to penetrate exceptionally dense crop canopies is:
(A) Spray volume is intercepted by the top canopy layer, and downward air pressure is brief
(B) Aircraft can only apply dry dusts during high-altitude maneuvers over the field
(C) The pump pressure cannot exceed 10 PSI on an agricultural aircraft for safety reasons
(D) Aircraft nozzles are structurally incapable of producing large droplets for canopy penetration

2010

155. Modern Unmanned Aerial Vehicles (UAVs/ Drones) in agriculture are primarily integrated to:
(A) Replace entirely the need for satellite imaging
(B) Provide targeted, precision spraying on difficult terrain and small fragmented fields
(C) Manually transport pesticide barrels across the farm
(D) Generate thermal inversions to protect crops from frost

2022

156. Which of the following statements about GPS guidance in aerial application is INCORRECT?
(A) It significantly reduces the occurrence of skipped areas and double overlaps
(B) It relies on visual human flaggers standing in the field to mark the swath width
(C) It allows for accurate tracking of flight paths

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(B) Regularly checking and replacing crankcase oil and lubricating grease fittings
(C) Operating the pump dry for 10 minutes after every use
(D) Using highly concentrated wettable powders to polish the cylinders

2008

120. If a diaphragm pump exhibits a sudden loss of pressure and spray liquid appears in the pump oil reservoir, what is the most likely cause?
(A) A clogged nozzle tip
(B) A faulty pressure relief valve
(C) A ruptured internal rubber diaphragm
(D) An empty spray tank

2021

121. The fundamental reason for thorough daily decontamination of a sprayer after using herbicides is to:
(A) Increase the tractor's fuel efficiency
(B) Lower the VMD of future spray applications
(C) Ensure the pump operates at maximum pressure
(D) Prevent severe phytotoxic damage to susceptible crops during subsequent applications

2022

122. The term "Personal Protective Equipment" (PPE) in pesticide application is defined as:
(A) Specialized clothing or equipment worn by an operator for protection against hazardous materials
(B) The shielding mounted on the tractor to prevent mechanical damage to the boom
(C) The chemical adjuvants added to formulations to protect the active ingredient from UV degradation
(D) The environmental barriers erected around a field to stop drift

2008

123. Which of the following is considered an INCORRECT safe handling practice during equipment operation?
(A) Wearing chemical-resistant gloves while mixing and loading concentrated pesticides
(B) Clearing a clogged nozzle by blowing into it directly with the mouth
(C) Reading and following the pesticide label instructions thoroughly
(D) Calibrating the sprayer with clean water prior to adding the pesticide formulation

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2024

124. What is the expected physiological effect if an operator fails to wear a respirator while operating a thermal fogger inside a greenhouse?
(A) Dermal sensitization and contact dermatitis
(B) Acute inhalation toxicity from concentrated pesticide fumes
(C) Hearing loss due to acoustic resonance
(D) Improved resistance to the active ingredient over time

2010

125. All of the following are primary components for an operator's PPE kit for applying highly toxic organophosphates EXCEPT:
(A) Cotton gloves
(B) Chemical-resistant apron
(C) Unvented safety goggles or a face shield
(D) Properly fitted respirator with appropriate chemical cartridges

2024

126. During the mixing and loading phase, the risk of operator exposure is generally highest because:
(A) The equipment is moving at high speeds
(B) The wind speed is typically higher near the loading zone
(C) The operator is handling the pesticide in its most concentrated form
(D) The nozzles are operating at maximum pressure

2013

127. Identify the correct pair matching the route of exposure with the appropriate protective PPE.
(A) Inhalation exposure - Steel-toed boots
(B) Ocular exposure - Chemical-resistant apron
(C) Dermal exposure on feet - Particulate respirator
(D) Dermal exposure on hands - Nitrile or neoprene gloves

2004

128. If an applicator accidentally spills concentrated pesticide on their protective coveralls, what is the immediate required action?
(A) Continue spraying but remain in direct sunlight to dry the spill
(B) Wait until the end of the shift to wash the coveralls
(C) Remove the contaminated clothing immediately and wash the affected skin thoroughly with soap and water
(D) Neutralize the spill with strong household bleach while wearing the coveralls

ANSWERS

1. (B) The expansion and deformation of a droplet upon impacting and wetting the target surface
Droplet spread dynamics refers to the physiological behavior of a spray droplet once it makes contact with a leaf or target surface. This process involves the kinetic energy of the impact causing the droplet to flatten, deform, and expand across the area. Factors such as surface tension and leaf morphology dictate the final coverage area achieved.

2. (D) The surface tension of the spray liquid and leaf topography
The retention of spray liquid on foliage depends on the interaction between the liquid's surface tension and the physical characteristics of the leaf. Surfaces with high wax content or intricate textures often repel droplets, while surfactants can lower surface tension to improve wetting. Once the liquid exceeds a specific volume, gravity overcomes adhesion, leading to runoff.

3. (A) Droplet size decreases, potentially improving coverage but increasing drift risk
Increasing hydraulic pressure forces liquid through the nozzle orifice at higher velocities, which enhances atomization and results in smaller droplets. While a finer spray spectrum increases the number of droplets and improves target coverage density, these small particles are significantly more susceptible to being carried away by wind. This balance is critical for maintaining effective pesticide application.

4. (C) Applying spray liquid until continuous heavy runoff occurs ensures maximum biological efficacy
Pesticide application aims for uniform coverage and maximum retention without excessive waste. Spraying until heavy runoff occurs is generally inefficient as the excess active ingredient drips off the target and onto the ground. This leads to environmental contamination and reduces the actual dose remaining on the foliage. Effective application focuses on achieving high droplet density before runoff begins.

5. (C) A is true but R is false.
Surfactants are added to pesticide formulations to decrease the surface tension of the liquid, which allows droplets to spread more effectively and adhere to waxy leaf surfaces. This increase in wetting improves retention and biological efficacy. The claim that surfactants increase surface tension is factually incorrect, as their primary chemical function is the reduction of interfacial tension.

6. (D) Halving the droplet diameter increases their total number eightfold for a given spray volume
The volume of a spherical droplet is proportional to the cube of its diameter. Consequently, if the diameter of the droplets in a spray is reduced by half, the volume of each individual droplet decreases by a factor of eight. For a constant total liquid volume, this mathematical relationship results in eight times more droplets being produced.

7. (B) Half of the spray volume consists of droplets larger than this value and half smaller
Volume Median Diameter is a critical parameter in spray characterization that indicates the median size of droplets based on volume. It represents the specific diameter where fifty percent of the total liquid volume is contained in droplets larger than the value, while the remaining half is contained in droplets smaller than that specific diameter. It is not numerical.

8. (C) A wide variation in droplet sizes within the spray spectrum
The ratio between the Volume Median Diameter and the Number Median Diameter measures the uniformity of a spray. A high ratio indicates a broad droplet size spectrum, meaning there is a significant discrepancy between the size of the most numerous droplets and those containing the most volume. This variability can lead to inconsistent coverage and higher drift potential.

9. (D) The median droplet size based on the numerical count of droplets in the spray cloud
Number Median Diameter is a statistical measure used to describe the droplet size distribution within a spray cloud. It identifies

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the diameter at which fifty percent of the total number of droplets are smaller and fifty percent are larger. This parameter provides insight into the numerical abundance of fine droplets, which are often critical for efficacy and drift.

10. (C) I and III
A monodisperse spray occurs when all droplets are the same size, resulting in a VMD to NMD ratio of exactly one. In contrast, agricultural nozzles produce a polydisperse spray where VMD is significantly larger than NMD. Rotary atomizers are more efficient at producing uniform droplets than standard hydraulic nozzles, leading to a narrower spectrum and lower ratio.

11. (B) VMD is larger than NMD because large droplets contain most of the total volume
In a typical agricultural spray spectrum, the Volume Median Diameter is always numerically higher than the Number Median Diameter. This occurs because the total volume is heavily weighted by the presence of larger droplets, even if they are fewer in number. Small droplets often dominate the numerical count but contribute very little to the overall liquid volume applied.

12. (B) It determines the exact forward speed required for the application equipment
The VMD to NMD ratio is an indicator of the uniformity and atomization quality of a spray cloud. While it provides essential information regarding droplet spectrum, coverage efficiency, and the potential risk of drift, it does not directly dictate the mechanical settings like tractor speed. Forward speed is determined by the desired application rate, swath width, and nozzle discharge.

13. (A) Volume is proportional to the cube of the diameter
For spherical spray droplets, the volume is calculated using the formula four-thirds multiplied by pi multiplied by the radius cubed. This geometric relationship implies that the volume of the droplet is directly proportional to the cube of its diameter. Small changes in the diameter lead to significant changes in the total liquid volume contained within each individual droplet.

14. (C) Less than 5 liters per hectare
Ultra-Low Volume application is a specialized technique characterized by applying extremely small amounts of total liquid per unit area. In the context of field crops, this typically involves rates of less than five liters per hectare. This method requires specialized atomizers, such as rotary discs, to break the concentrated pesticide into very fine droplets for adequate coverage.

15. (A) P-3, Q-2, R-1, S-4
Spray volumes are classified by the total liquid applied per hectare. High Volume exceeds four hundred liters to achieve thorough wetting. Medium Volume ranges between fifty and four hundred liters, while Low Volume uses five to fifty liters. Ultra-Low Volume is the most concentrated, applying less than five liters per hectare, often requiring specialized equipment to ensure effective distribution.

16. (C) Applying spray liquid to thoroughly wet the foliage, often to the point of run-off
High Volume spraying involves the application of large quantities of diluted pesticide mixture to a target area. The primary objective is to achieve maximum coverage by completely wetting the leaf surfaces and stems of the crop. This method often continues until the liquid begins to run off the foliage, ensuring that every part of the plant is adequately treated.

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17. (B) It relies entirely on continuous heavy runoff to achieve pest control
Low Volume spraying is designed to reduce the amount of water required for pesticide application by using more concentrated mixtures. Unlike High Volume methods, it does not aim to achieve runoff. Instead, it utilizes finer droplets to maintain adequate coverage density across the foliage. This approach saves significant labor and time while still providing effective control of the targeted pests.

18. (D) Ultra-Low Volume (ULV) - Motorized knapsack mist blower with a restrictor
Ultra-Low Volume applications require specialized equipment to handle concentrated formulations and produce very fine droplets. A motorized knapsack mist blower can be adapted for this purpose by installing a restrictor to control the flow rate precisely. This setup allows for the efficient application of pesticide at very low rates, typically less than five liters per hectare of crop.

19. (A) Ultra-Low Volume application using aerial or specialized ULV equipment
In water-scarce agricultural regions where rapid treatment of large areas is necessary, Ultra-Low Volume application is the most efficient choice. This technique minimizes the need for water as a carrier by using concentrated pesticide formulations. Aerial equipment or specialized ground-based ULV atomizers can cover vast distances quickly, significantly reducing the logistical burden of transporting large volumes of water.

20. (A) I and III
High relative humidity actually decreases the evaporation rate of droplets, which can reduce drift risk compared to dry conditions. Additionally, spray drift is a concern for both aerial and ground applications, not just the former. Droplets smaller than fifty microns are highly susceptible to wind movement, and increasing boom height significantly enhances the potential for off-target displacement.

21. (A) Thermal convection currents (updrafts)
Thermal convection currents are created when the sun heats the ground, causing air to rise. These updrafts can easily pick up fine spray droplets and transport them high into the atmosphere. Once suspended, these droplets can be carried long distances by horizontal winds before settling, leading to significant off-target contamination and reduced efficacy in the intended treatment area.

22. (D) Fine droplets remain suspended in clouds and move laterally off-target
A temperature inversion occurs when warm air sits above cooler air near the ground, creating highly stable atmospheric conditions. During these periods, fine spray droplets do not disperse vertically but instead remain concentrated in a suspended cloud. This cloud can drift laterally for several miles with the slightest breeze, posing a severe risk of damage to sensitive off-target areas.

23. (B) Elevating the spray boom to maximum height
Increasing the height of the spray boom is a practice that significantly exacerbates drift risk rather than reducing it. Higher boom levels provide more time for wind to intercept droplets before they reach the target. Effective drift reduction strategies include using air-induction nozzles, adding drift retardants to the tank mix, and utilizing shielded booms to protect the spray pattern.

24. (C) Air-induction nozzles create larger, air-filled droplets that shatter on impact
Air-induction or venturi nozzles work by drawing air into the liquid stream to create larger droplets that contain air bubbles. These coarse droplets are much less likely to drift than the fine particles produced by standard nozzles. Upon impacting the leaf surface, the air-filled droplets shatter into smaller fractions, providing adequate coverage while maintaining a drift-resistant spray spectrum.

25. (A) Strong wind with temperature inversion → Moderate wind under stable sky → Calm wind with high humidity
The highest drift risk occurs during strong winds combined with a temperature inversion, as droplets are carried laterally without dispersion. Moderate winds under stable conditions represent a significant but lower risk. The lowest risk is found in calm winds with high humidity, where low air movement and reduced evaporation rates help droplets settle quickly and accurately on the intended target.

26. (A) Vapor drift
Vapor drift occurs when the active ingredient of a pesticide evaporates after it has been applied to the target surface. These volatile gases can then be transported by air currents to sensitive non-target areas. This phenomenon is distinct from particle drift, which involves the movement of liquid droplets or solid particles during the actual application process itself.

27. (B) Maintain uniform suspension or mixture of the pesticide formulation in the diluent
The primary role of an agitator in a sprayer tank is to ensure that the pesticide remains thoroughly mixed with the water or carrier. This is especially critical for formulations like wettable powders that do not dissolve but stay in suspension. Constant agitation prevents the chemical from settling at the bottom, ensuring a consistent concentration throughout the application process.

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47. (D) The cap assembly connects the nozzle directly to the tractor's PTO shaft
The cap assembly of a nozzle is designed to secure the nozzle tip and strainer to the nozzle body, not to the tractor's power take-off shaft. The nozzle body itself is attached to the spray boom. The PTO shaft is used to drive the hydraulic pump, while the nozzle components are focused on filtering, housing, and shaping the final spray pattern.

48. (C) Nozzle tip - Determines the atomization pattern and discharge capacity
The nozzle tip is the most vital component of any hydraulic sprayer, as its orifice size and shape directly dictate the volume of liquid discharged and the resulting spray pattern. Other components include the nozzle body for housing, the strainer for filtering debris, and the cap assembly to hold everything in place. None of these components control the tractor's forward speed.

49. (B) Its resistance to physical wear and chemical corrosion over time
Nozzle tips are manufactured from various materials such as brass, stainless steel, ceramic, or polymer. The choice of material primarily determines how quickly the orifice will enlarge due to the abrasive nature of some pesticides and how well it resists chemical corrosion. Ceramic and hardened stainless steel generally offer the longest service life, maintaining an accurate discharge rate for longer.

50. (D) I only
Nozzle strainers are essential for preventing clogs and are often graded by mesh size, where a higher number indicates a finer screen. Some strainers also incorporate check valves to prevent dripping when pressure drops. However, they are not color-coded to match the tractor brand; instead, color coding typically follows international standards to indicate the mesh size or nozzle capacity.

51. (A) Quick-attach (bayonet-style) cap assemblies
Modern sprayers often utilize bayonet-style or quick-attach cap assemblies that allow operators to change or clean nozzle tips rapidly by hand. These caps lock into the nozzle body with a simple partial turn, eliminating the need for wrenches or other tools in the field. This convenience improves efficiency and encourages regular maintenance, ensuring that the spray patterns remain consistent and effective.

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52. (C) Hollow cone nozzle
The hollow cone nozzle is characterized by an internal core or swirl plate that induces a high-velocity rotational motion to the liquid before it exits the orifice. This centrifugal action creates a circular spray pattern with a concentrated ring of droplets and an empty center. This specific anatomical feature is not found in standard flat fan or floodjet nozzle designs.

53. (A) It emits liquid in a tapered or even sheet-like elliptical pattern
A flat fan nozzle is designed to produce a narrow, elliptical, or sheet-like spray pattern. This pattern is ideal for broadcast applications across a field because it allows for uniform distribution when the edges of adjacent patterns are overlapped. These nozzles are widely used for herbicide applications where consistent coverage on the soil or crop surface is required for maximum efficacy.

54. (D) Produce larger droplets and distribute liquid throughout the circular impact area
Solid or full cone nozzles differ from hollow cone nozzles by distributing spray droplets throughout the entire circular impact area rather than just in an outer ring. They generally produce a coarser spray spectrum with larger droplets, making them suitable for high-volume applications where thorough wetting is needed. They also incorporate internal components to create the necessary turbulence for a full pattern.

55. (A) Both A and R are true and R is the correct explanation of A.
Floodjet or deflector nozzles are highly effective for applying soil-active herbicides and liquid fertilizers. Their design allows them to operate at very low pressures, which results in a wide spray angle and the production of large, heavy droplets. These characteristics make the spray highly resistant to wind drift, ensuring that the chemicals are placed accurately on the soil surface.

56. (C) Floodjet (deflector) nozzle
The floodjet nozzle operates by directing a high-pressure stream of liquid through a circular orifice to strike a smooth, angled deflector surface. This impact causes the liquid to spread

37. (A) It traps liquid between teeth of rotating, meshing gears and forces it to the outlet
A gear pump is a type of positive displacement pump that operates by using two meshing gears to move liquid. As the gears rotate, they create a vacuum at the inlet, trapping liquid between the gear teeth and the pump casing. The fluid is then carried around to the discharge side and forced out as the gears mesh back together.

38. (D) A positive displacement pump generating high pressures, ideal for orchard sprayers
Plunger pumps are a robust category of positive displacement pumps capable of generating very high operating pressures. They function by using reciprocating pistons to force liquid through the system. Their ability to maintain high pressure and consistent flow makes them particularly well-suited for specialized applications like orchard spraying, where the liquid must be projected into dense, tall tree canopies.

39. (B) Roller vane pump
For a standard tractor-mounted boom sprayer applying non-abrasive emulsions at low pressures, the roller vane pump is an economical and operationally appropriate choice. These pumps are simple in design, easy to maintain, and can be driven directly by the tractor's power take-off. They provide sufficient flow and pressure for most broadcast herbicide applications while remaining relatively cost-effective.

40. (C) P-2, Q-4, R-3, S-1
Calibration variables are essential for accurate pesticide application. Swath width represents the total width treated in one pass. Forward speed is the travel velocity across the field. Discharge rate refers to the volume of liquid emitted per minute from the nozzles. Finally, application volume is the resulting amount of liquid applied per unit of area, typically measured in liters per hectare.

41. (D) (Swath width in meters × Forward speed in km/h)
The standard mathematical formula to determine the application volume per hectare for a boom sprayer integrates the discharge rate, travel speed, and swath width. Specifically, the value is calculated by multiplying the total nozzle discharge in liters per minute by a constant of six hundred, then dividing that result by the product of the swath width and the forward speed.

42. (A) Double
The application volume per unit area is inversely proportional to the forward speed of the sprayer. If an operator reduces the tractor's speed by half while the nozzle discharge rate and swath width remain constant, the equipment will spend twice as much time over every part of the field. Consequently, the total volume of liquid applied per hectare will double.

43. (B) The number of nozzles multiplied by the distance between adjacent nozzles
For a broadcast boom sprayer, the effective swath width is the total horizontal distance covered by the spray pattern during a single pass. This is mathematically determined by multiplying the total number of nozzles mounted on the boom by the spacing between each nozzle. This measurement is critical for calculating the correct application rate and ensuring uniform coverage across the field.

44. (B) The relative humidity of the surrounding air
While relative humidity is an important environmental factor that affects droplet evaporation and drift, it is not a direct parameter required for calculating the mechanical calibration of a sprayer. Calibration focuses on physical measurements such as the actual forward speed of the tractor, the liquid discharge rate from the nozzles, and the effective swath width to ensure accurate pesticide dosing.

45. (A) II → III → IV → I
Effective sprayer calibration follows a logical sequence of steps to ensure accuracy. First, the effective swath width of the boom must be established. Second, the actual forward speed of the tractor is measured under field conditions. Third, the nozzle discharge rate is determined by collecting liquid over time. Finally, these variables are used to calculate the application volume per hectare.

46. (C) Clean or replace the faulty nozzle tip and strainer
If a single nozzle on a spray boom is discharging significantly less liquid than the others, it indicates a partial blockage or a worn component. The most appropriate immediate action is to inspect, clean, or replace both the nozzle tip and its associated strainer. Simply increasing the overall system pressure would not resolve the localized issue and would lead to over-application.

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motorized or tractor-mounted power dusters are used to cover extensive acreages more efficiently than manual tools.

84. (C) A continuous and regulated amount of dust drops into the air stream
A critical component of a power duster is the feeding mechanism located at the base of the hopper. Its function is to ensure that a consistent and regulated amount of dry pesticide is introduced into the high-velocity air stream. This allows for a uniform application rate across the field and prevents the air stream from becoming clogged or carrying insufficient chemical.

85. (A) P-2, Q-1, R-3, S-4
Fogging and spraying equipment operate on distinct principles. Thermal foggers use heat to vaporize pesticide in oil, creating a visible cloud. Cold aerosol generators use mechanical shearing to create fine droplets without heat. Plunger dusters rely on a simple piston to push dry powder through a tube. Standard knapsack sprayers use hydraulic pressure to force liquid through a nozzle orifice for application.

86. (D) Adulticiding for mosquito control in residential or semi-enclosed spaces
Thermal fogging is most effectively used in residential or semi-enclosed environments for public health pest control, such as killing adult mosquitoes. The very fine, buoyant droplets produced by thermal vaporization can linger in the air and penetrate into crevices where insects hide. It is generally unsuitable for open-field herbicide applications because the tiny droplets are extremely prone to drifting away from the target.

87. (B) They degrade heat-sensitive active ingredients significantly during atomization
Cold aerosol generators, also known as ULV foggers, are specifically designed to produce fine droplets using mechanical energy, such as high-velocity air or rotary atomizers, instead of heat. Because they do not rely on high temperatures, they do not degrade heat-sensitive pesticide active ingredients. This makes them a preferred choice over thermal foggers for certain sensitive chemical formulations used in indoor pest control.

88. (C) Thermal foggers use heat vaporization, while cold foggers use mechanical atomization
The primary distinction between thermal and cold foggers is the method used to create fine droplets. Thermal foggers inject a pesticide-oil mixture into a hot gas stream to vaporize it, which then condenses into a visible fog. Cold foggers achieve atomization using mechanical means, such as specialized nozzles or high-speed air, avoiding the use of heat and the risk of chemical degradation.

89. (D) A volatile oil carrier, such as diesel or kerosene
Thermal foggers require a carrier that can be easily vaporized and then condensed into a stable, visible fog. Volatile oil carriers, such as diesel, kerosene, or specialized fogging oils, are typically used for this purpose. When the pesticide mixture is injected into the hot exhaust gases, these oils vaporize instantly, carrying the active ingredient into the air as microscopic droplets.

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90. (B) III → IV → I → II
The generation of thermal fog follows a specific sequence. First, the pesticide solution is injected into the hot exhaust gases within the resonator pipe. Second, the heat instantly vaporizes both the active ingredient and the oil carrier. Third, this vaporized mixture exits the pipe and meets the cooler ambient air. Finally, the rapid temperature drop causes the vapor to condense into fog.

91. (B) Igniting a pyrotechnic mixture integrated with the active ingredient to produce toxic smoke
A smoke generator functions by using a pyrotechnic or combustible mixture that is integrated with a specific pesticide active ingredient. Once ignited, the chemical reaction produces a large volume of smoke that carries the pesticide into the air. This method is primarily used for space treatments in enclosed areas where the smoke can circulate and reach all surfaces and hidden pests.

92. (B) Treating vast open agricultural fields for weed control
Smoke generators are designed for space treatments in enclosed or well-sealed environments like greenhouses, grain silos, and transport containers. They are completely unsuitable for treating open agricultural fields for

out into a wide, flat sheet before breaking into droplets. This design is particularly useful for applications requiring a wide swath at low pressures with minimal risk of producing drift-prone fine particles.

57. (D) They are the preferred nozzle type for broadcast application of systemic herbicides on soil
Hollow cone nozzles are primarily designed to produce fine droplets that offer excellent penetration into dense crop foliage, making them ideal for contact fungicides and insecticides. They are not the preferred choice for broadcast systemic herbicides on soil because their fine spray spectrum increases drift risk and their circular pattern is less uniform for large-scale soil coverage than flat fan nozzles.

58. (A) Uneven distribution, with lower application rates at the edges of the swath
Tapered flat fan nozzles are engineered to produce a spray pattern that is heavier in the center and lighter at the edges. To achieve uniform coverage across the entire width of a boom, the patterns from adjacent nozzles must overlap, typically by thirty to fifty percent. Without this overlap, the area between nozzles will receive a significantly lower dose of pesticide.

59. (B) Hollow cone nozzle
When applying contact fungicides or insecticides, achieving thorough coverage and penetration into the canopy is essential. Hollow cone nozzles are the most appropriate selection for this task because they produce a fine droplet spectrum and a swirling spray pattern. These characteristics allow the droplets to reach the undersides of leaves and penetrate deep into dense foliage, maximizing biological efficacy.

60. (C) I, II and IV
Standard flat fan nozzles are the primary choice for broadcast herbicide applications and require a specific overlap between adjacent patterns to ensure uniform distribution. The spray angle of the nozzle is a key factor in determining the correct boom height. However, they do not generate massive droplets at high pressures; instead, increasing pressure typically results in a finer, drift-prone spray.

61. (A) Air-induction flat fan or standard flat fan at low pressure
Systemic herbicides require adequate coverage but do not always need the extremely fine droplets used for contact pesticides. To minimize drift risk while maintaining efficacy, air-induction flat fan nozzles or standard flat fan nozzles operated at low pressures are recommended. These nozzles produce larger, more stable droplets that are less likely to move off-target while still providing uniform soil or foliage coverage.

62. (C) Discharge flow rate at a standard pressure
The international ISO color-coding system for agricultural nozzles is used to indicate the discharge flow rate of the nozzle tip at a specific standard pressure. This allow operators to easily identify and match nozzles with the same capacity across the boom. It does not indicate the nozzle's chemical resistance, the manufacturer's brand, or the specific operating pressure required for atomization.

63. (D) Selecting nozzles that produce a VMD of 100 microns or less
Minimizing spray drift requires selecting nozzles and operating conditions that produce larger droplets. Droplets with a Volume Median Diameter of one hundred microns or less are extremely fine and highly susceptible to wind movement. Effective drift reduction involves using air-induction nozzles, choosing larger orifice sizes, and operating at lower pressures to ensure that the spray spectrum contains fewer fine particles.

64. (B) Even flat fan nozzles should be selected to apply a uniform dose across the entire band width
Band spraying involves applying a pesticide only over a narrow strip, such as a crop row. For this application, even flat fan nozzles are the best choice because they are designed to provide a perfectly uniform distribution across the entire width of their single pattern. Standard tapered nozzles are unsuitable because they require overlap to achieve uniformity, which is not possible in a single-nozzle band setup.

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65. (B) P-3, Q-4, R-1, S-2
Different application scenarios require specific nozzle types for optimal results. Systemic herbicides are typically broadcast using standard or air-induction flat fan nozzles. Fungicides in

dense canopies benefit from the fine droplets of hollow cone nozzles. Liquid fertilizers are often applied with floodjet nozzles to reduce drift, while even flat fan nozzles are ideal for precise band applications over crop rows.

66. (D) 10 to 20 liters
Manually operated knapsack sprayers are designed to be portable and carried on the operator's back. To balance the need for sufficient liquid to cover a reasonable area with the physical limitations of the human operator, these sprayers typically have a tank capacity between ten and twenty liters. Larger capacities would be too heavy and ergonomically unsafe for extended periods of manual use.

67. (A) Air is pumped into the sealed tank above the liquid to create the spraying pressure
A pneumatic or compression sprayer operates by manually pumping air into a sealed tank partially filled with spray liquid. This air becomes compressed in the headspace above the liquid, creating the pressure necessary to force the pesticide through the discharge hose and nozzle. Unlike lever-operated knapsack sprayers, the operator does not need to pump continuously while the actual spraying is occurring.

68. (C) Foot (pedal) sprayer or rocking sprayer
Treating tall fruit trees requires a sprayer capable of generating high enough pressure to project the liquid into the upper canopy. Foot-operated pedal sprayers or rocking sprayers are designed for this purpose. They utilize the stronger muscles of the legs or a long-handled lever to build significant pressure, allowing for a vertical spray reach that smaller handheld or knapsack sprayers cannot achieve.

69. (A) The expansion of air space as liquid is depleted, lowering the internal pressure
As liquid is discharged from a pneumatic compression sprayer, the volume of compressed air in the tank's headspace increases to fill the vacated space. This expansion causes a corresponding drop in the internal air pressure according to Boyle's Law. Consequently, the spray pressure and swath width will steadily decline during operation until the operator re-pumps the tank to restore the pressure.

70. (A) Fill tank with mixture → Seal tank tightly → Pump air to desired pressure → Open trigger valve to spray
The correct operation of a pneumatic sprayer begins with filling the tank with the prepared pesticide mixture. The tank must then be sealed tightly to ensure it is airtight. The operator then pumps air into the tank to create the required compression. Once the desired pressure is reached, the trigger valve is opened to begin the application process through the nozzle.

71. (B) Inside or adjacent to the tank, operated by a hand lever
In a standard lever-operated knapsack sprayer, the pump assembly is typically mounted either inside the spray tank or immediately adjacent to it. This pump is connected to a hand-operated lever that the operator moves up and down continuously during the spraying process. This action draws liquid from the tank and forces it under pressure through the hose and the discharge nozzle.

72. (C) It functions exclusively as a High Volume (HV) hydraulic sprayer
Motorized knapsack mist blowers are primarily designed for Low Volume and Ultra-Low Volume applications. They utilize a small engine to drive a fan, creating a high-velocity air stream that shears the liquid into fine droplets. While they can be adjusted, they do not function exclusively as high-volume hydraulic sprayers, as their main advantage is the air-assisted delivery of concentrated mist.

73. (D) The air-blast sprayer uses forced air to propel droplets into tree canopies
A tractor-mounted boom sprayer is designed for uniform broadcast application on low-growing field crops using hydraulic nozzles. In contrast, an orchard air-blast sprayer is specifically built for tree crops. It combines hydraulic atomization with a powerful fan that generates a massive volume of forced air. This air stream carries the spray droplets deep into the dense, vertical architecture of tree canopies.

74. (A) Shearing of the liquid fed into a high-velocity air stream generated by a centrifugal fan
The atomization in a motorized knapsack mist blower occurs through a process called air-shear. Liquid is fed at low pressure into a high-velocity air stream generated by a centrifugal fan. The

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force of the moving air strips droplets away from the liquid stream, breaking them into a fine mist. This method is highly effective for projecting spray over distance and into dense foliage.

75. (C) II and III
Orchard air-blast sprayers are typically powered by the tractor's Power Take-Off and are unfortunately known for having a high drift potential due to the powerful fan. While they are excellent for canopy penetration and use a combination of hydraulic nozzles and forced air, the air stream can easily carry fine droplets beyond the target area if wind conditions are not carefully monitored.

76. (B) The boom is attached to the rear of the tractor and oriented horizontally across the crop
A trailing edge boom on a tractor-mounted sprayer refers to a horizontal structure mounted at the rear of the equipment. This boom holds several nozzles at regular intervals to provide uniform broadcast coverage of field crops as the tractor moves forward. The term emphasizes its location behind the tractor, which helps protect the operator from the spray and ensures stable application.

77. (A) The boom height is fixed and cannot be adjusted for different crop stages
Modern tractor-mounted boom sprayers are designed with adjustable boom heights to accommodate different stages of crop growth and to ensure the correct nozzle overlap. Maintaining the proper height is essential for achieving uniform coverage and minimizing drift. These sprayers also include standard components like pumps driven by the PTO, pressure regulators, agitators, and multiple strainers to ensure efficient and reliable operation.

78. (C) Changing the liquid tank to a hopper and installing a dusting attachment
Many motorized knapsack mist blowers are versatile machines that can be converted to apply dry formulations like dusts or granules. This conversion involves replacing the liquid spray tank with a specialized hopper and installing a dusting attachment. The high-velocity air stream generated by the engine's fan is then used to pick up and blow the dry particles onto the target crop.

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79. (D) Suspend dry pesticide particles in a forced air stream for delivery to the target
The fundamental principle of a duster is the delivery of pesticide in a dry, powdered form. The equipment uses a fan or bellows to create a forced air stream. Dry pesticide particles are metered from a hopper into this air stream, which suspends the particles and carries them to the target foliage. This method is useful in areas where water is scarce.

80. (A) Both A and R are true and R is the correct explanation of A.
Pesticide dusts are notorious for having a very high drift potential compared to liquid sprays. This is because the dust particles are manufactured to be extremely fine and lightweight. Unlike liquid droplets, they lack the significant mass and moisture required to settle quickly onto the target. Consequently, even a very light breeze can carry these dry particles far away from the intended area.

81. (B) A manually operated machine using a hand crank to drive a fan that blows dust from a hopper
A hand rotary duster is a simple, portable piece of equipment used for applying dry pesticide powders. It features a hopper to hold the dust and a hand-cranked mechanism that drives a high-speed fan. As the operator turns the crank, the fan generates an air stream that picks up the dust and projects it through a discharge tube onto the target plants.

82. (D) The presence of daily dew on the leaf surface early in the morning
Because pesticide dusts are dry, they often struggle to adhere to foliage, especially in dry or windy conditions. The presence of dew on the leaves early in the morning provides a moist surface that helps capture and hold the fine dust particles. This significantly improves the retention and biological efficacy of the treatment, making early morning the ideal time for dusting.

83. (A) Hand rotary duster - Small to medium scale field crops or specific pest spots
Dusting equipment is selected based on the scale of the application area. Hand rotary dusters are ideal for small to medium-scale operations or for spot-treating specific pest infestations. Plunger dusters are even smaller and suited for kitchen gardens. For large-scale commercial operations,

28. (B) They automatically adjust the tractor's forward speed to maintain a constant application rate
Pressure regulators are essential components that control the hydraulic pressure of the liquid delivered to the nozzles. They function by bypassing excess flow back to the tank, which also protects system components from damage. However, they do not have any mechanical or electronic control over the tractor's ground speed, which must be managed independently by the equipment operator.

29. (A) A mechanical or hydraulic agitator
Wettable powder formulations consist of solid particles that do not dissolve in water but form a suspension. Without continuous movement, these particles will naturally settle at the bottom of the spray tank, leading to blocked lines and uneven application rates. An agitator, whether mechanical or hydraulic, provides the necessary turbulence to keep the particles uniformly distributed throughout the liquid.

30. (C) I, II, III and V
A standard tractor-mounted boom sprayer includes several essential components to function effectively. These typically consist of a pump to pressurize the system, a pressure regulator to maintain the desired output, an agitator to keep the mixture uniform, and nozzle bodies to distribute the spray. Drone flight controllers are specialized electronics for unmanned aircraft and are not found on ground-based sprayers.

31. (D) Routing pressurized liquid from the pump back to the tank through a specialized nozzle
Hydraulic agitation is a method used to keep pesticide mixtures suspended in the spray tank without using mechanical paddles. This is achieved by diverting a portion of the pressurized liquid from the pump output back into the tank. The liquid is discharged through specialized nozzles or orifices, creating sufficient turbulence and flow to prevent any solid particles from settling.

32. (C) They prevent nozzle blockages and protect the pump from abrasive wear
Strainers are filtration components placed at various points in the sprayer system, including the tank opening, suction line, and nozzle bodies. Their primary function is to remove debris and undissolved particles from the spray liquid. By doing so, they prevent the small orifices of the nozzles from clogging and protect sensitive pump parts from being damaged by abrasive materials.

33. (B) Severe damage to the pump or bursting of hoses if a relief valve is not present
Positive displacement pumps, such as piston or diaphragm types, continue to move a fixed volume of liquid with every stroke regardless of the system pressure. If the discharge line is closed and no relief valve is present to bypass the fluid, the pressure will rapidly increase until a mechanical failure occurs. This often results in burst hoses or pump housing damage.

34. (D) Centrifugal pump
A centrifugal pump is classified as a non-positive displacement pump. It uses a high-speed rotating impeller to impart kinetic energy to the liquid, creating flow through centrifugal force. Unlike plunger, diaphragm, or gear pumps, its output volume decreases as the system pressure or resistance increases. If the discharge line is closed, the liquid will simply recirculate within the pump housing.

35. (A) Both A and R are true and R is the correct explanation of A.
Diaphragm pumps are ideal for handling abrasive pesticide formulations like wettable powders. This suitability arises from their design, where a flexible rubber or synthetic diaphragm separates the moving mechanical components from the corrosive or abrasive spray liquid. Because the liquid does not come into contact with the pistons or cylinders, the internal parts are protected from excessive wear.

36. (C) Roller pumps are more susceptible to wear from abrasive materials than plunger pumps
Roller pumps are generally used for low-pressure applications and are sensitive to abrasive formulations because the rollers and pump housing are in direct contact with the spray liquid. In contrast, plunger pumps are designed for high-pressure durability and can handle abrasive materials more effectively, especially if equipped with ceramic components. Plunger pumps are commonly used in high-pressure orchard spraying.

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weed control. In an open environment, the light smoke particles would immediately disperse and drift away with the wind, making it impossible to achieve an effective dose on the target weed species.

93. (A) The smoke can easily escape through gaps, leading to sub-lethal dosing and reduced efficacy
For a smoke generator to be effective, the treated space must be tightly sealed to maintain a lethal concentration of the pesticide for a specific period. In poorly sealed areas, the buoyant smoke particles easily escape through gaps and vents. This leads to a rapid decline in the concentration of the active ingredient, resulting in sub-lethal doses that fail to control the target pests.

94. (C) Many active ingredients are thermally unstable and degrade completely upon ignition
Smoke generators rely on the heat of a pyrotechnic reaction to disperse the pesticide. However, many common pesticide active ingredients are thermally unstable and will break down chemically when exposed to high temperatures. If the active ingredient degrades during the ignition process, it loses its biological activity, rendering the treatment ineffective. Therefore, only heat-resistant chemicals can be formulated for use in smoke generators.

95. (D) I and II
Smoke generators are advantageous because they require no external power or complex machinery, making them very easy to deploy. The resulting smoke acts as a space treatment, filling the entire volume of an enclosed area. However, they are not safe to handle with bare hands immediately after ignition, as the canisters become extremely hot and may contain hazardous chemical residues.

96. (C) The generator must be placed on a heat-resistant surface and the area evacuated immediately after ignition
Safety is paramount when using smoke generators. Because the pyrotechnic reaction generates significant heat, the canister must be placed on a non-combustible, heat-resistant surface to prevent fires. Furthermore, the smoke contains concentrated pesticide, requiring all personnel to evacuate the area immediately after ignition. The space should remain sealed for the duration of the treatment and then be thoroughly ventilated.

97. (B) A soil injecting gun or a tractor-mounted shank injector
Volatile soil fumigants must be placed directly beneath the soil surface to be effective against nematodes and other soil-borne pests. This requires specialized equipment such as a manual soil injecting gun for small areas or a tractor-mounted shank injector for large-scale field applications. These tools deliver the liquid into the root zone where it can vaporize and move through the soil pores.

98. (D) They require high-pressure hydraulic pumps to force the granules into the soil
Soil granular applicators are designed to meter out dry, solid particles, not liquids. Therefore, they do not utilize high-pressure hydraulic pumps, which are characteristic of liquid sprayers. Instead, these machines rely on gravity-fed hoppers or mechanical metering systems, sometimes assisted by a low-pressure air stream, to deliver the granules into a band on the surface or directly into the seed furrow.

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99. (A) Deliver a measured dose of liquid pesticide beneath the soil surface near plant roots
A soil injecting gun is a specialized tool used to apply liquid pesticides, typically fumigants or systemic insecticides, directly into the soil. The operator inserts a probe into the ground, and a calibrated mechanism delivers a precise dose of the chemical at a specific depth. This targeted approach ensures that the pesticide is placed exactly where soil-dwelling pests or plant roots are located.

100. (A) Both A and R are true and R is the correct explanation of A.
Soil fumigation relies on the active ingredient transforming into a gaseous phase to permeate the soil and kill pests. Because these gases are highly volatile, they will rapidly escape from the soil into the atmosphere if the surface is not sealed. Sealing is typically achieved by compacting the top layer of soil with a roller or by covering the area with plastic tarps.

101. (A) The positive displacement metering pump or orifice plate
Precise delivery of soil fumigants is critical for both efficacy and safety. In a tractor-mounted shank injector, this accuracy is maintained using a positive displacement metering pump or a series of calibrated orifice plates. These

154. (A) Spray volume is intercepted by the top canopy layer, and downward air pressure is brief
Aerial applications often struggle with deep canopy penetration because the majority of the spray volume is intercepted by the uppermost leaves. While aircraft generate some downward air pressure, it is often too brief to force the fine droplets deep into a dense crop. This results in excellent coverage on the top of the plants but significantly reduced efficacy for pests living lower down.

155. (B) Provide targeted, precision spraying on difficult terrain and small fragmented fields
Unmanned Aerial Vehicles are becoming increasingly integrated into agriculture to fill the gap between ground-based sprayers and manned aircraft. Their primary role is to provide targeted, precision spraying in areas that are difficult for tractors to access, such as steep slopes or small, fragmented fields. Drones offer a cost-effective and flexible solution for spot-treating infestations and managing smaller agricultural operations efficiently.

156. (B) It relies on visual human flaggers standing in the field to mark the swath width
GPS guidance systems have revolutionized aerial application by providing precise navigation without the need for visual human flaggers. These systems use satellite data to guide the pilot, ensuring that each swath is placed accurately. This significantly reduces the occurrence of skipped areas or double-sprayed overlaps. GPS also enables the recording of precise application data for legal compliance and future management decisions.

157. (A) Utilizing spatial data to apply agrochemicals only where needed, at the exact required dose
Precision spraying with drone technology involves the integration of spatial data and advanced sensors to target specific areas of a field. Instead of applying a uniform dose across the entire crop, the drone uses prescription maps to identify and treat only the infested or stressed zones. This approach significantly reduces the total amount of chemical used, lowers costs, and minimizes environmental impact.

158. (C) Improved canopy penetration and under-leaf coverage of the spray droplets
One unique advantage of using multi-rotor drones for pesticide application is the significant downward thrust, known as rotor wash, generated by their propellers. This moving air column helps to displace the crop foliage as the drone flies overhead, allowing the spray droplets to penetrate deeper into the canopy. It also promotes turbulence that can improve the coverage on the undersides of leaves.

159. (D) Very limited battery life and small payload capacities compared to manned aircraft
While highly precise, current electric multi-rotor agricultural drones face significant operational limitations. Their battery technology currently allows for relatively short flight times, often requiring frequent charging or battery swaps. Furthermore, their payload capacity for pesticide liquid is quite small compared to manned aircraft or tractor-mounted sprayers. This necessitates frequent landings for refilling, which can limit their overall efficiency for large-scale application tasks.

160. (B) The creation of prescription maps, enabling targeted spot-spraying of infested areas
Integrating multispectral imaging with drone technology allows farmers to identify pest infestations or nutrient deficiencies before they are visible to the human eye. The data collected from these sensors is used to create detailed prescription maps. These maps guide the spray drone to apply pesticides or fertilizers only in the specific areas that require treatment, enhancing the efficiency and sustainability.

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eliminate soil pathogens. Infrared heaters use radiant heat to destroy weed tissues without an open flame. Hot water applicators apply boiling liquid to control weeds, which is particularly useful in municipal areas where chemicals or flames are prohibited.

111. (D) It provides long-lasting residual control of weed seeds deep within the soil profile
Thermal weed control using flame throwers works by delivering a rapid spike in temperature that ruptures the plant's cells, leading to dehydration and death. While effective against young broadleaf weeds, it is a surface-level treatment. It does not provide any residual control and has little to no effect on weed seeds buried deep within the soil profile, which will likely germinate later.

112. (C) It leaves no chemical residues in the soil or crop
One of the primary advantages of using thermal weed control, such as a flame thrower, is that it is a physical process rather than a chemical one. Consequently, it leaves absolutely no chemical residues in the soil or on the harvested crop. This makes it an attractive option for organic farming systems and for applications in environmentally sensitive areas where herbicide persistence is a concern.

113. (B) Liquefied Petroleum Gas (LPG) or Propane
Modern agricultural flame throwers and thermal weed control implements primarily use Liquefied Petroleum Gas or Propane as their fuel source. These fuels are preferred because they are easy to transport in pressurized tanks, burn cleanly, and provide a high-intensity heat that is necessary for the rapid cell-rupturing process required for effective weed control. They also allow for precise control of the flame intensity.

114. (D) Severe phytotoxicity or destruction of the desired crop
The effectiveness of thermal weed control depends on the duration of heat exposure. If a flame thrower is operated too slowly over a crop canopy, the plants will be exposed to high temperatures for an excessive period. This will lead to severe phytotoxicity or the complete destruction of the desired crop along with the weeds, as most crops cannot withstand prolonged direct heat.

115. (A) I, II, III and V
Operating thermal pest control equipment requires strict safety adherence. Gas leaks must always be checked using soapy water rather than an open flame. Fire hazards are extreme when working near dry crop residues, and fuel tanks must be shielded from direct heat. While shielded burners protect crop rows, thermal equipment should never be used to apply flammable chemical pesticides due to the explosion risk.

116. (C) A systematic process of washing out empty pesticide containers three times to ensure maximum removal of residues
Triple rinsing is a critical environmental and safety procedure for managing empty pesticide containers. It involves adding water to the empty container, shaking it thoroughly, and pouring the rinsate into the spray tank, repeating this process three times. This ensures that virtually all concentrated pesticide residues are removed from the container, making it safer for disposal or recycling and preventing environmental contamination.

117. (A) Using a metal wire or pin to aggressively clear out the nozzle orifice
Nozzle orifices are precisely engineered to provide specific flow rates and patterns. Using a metal wire or pin to clean them can easily scratch or enlarge the orifice, permanently damaging the nozzle's performance. Recommended cleaning practices include using a soft-bristled toothbrush, soaking the tips in a suitable solvent, or using compressed air to clear blockages without compromising the integrity of the nozzle material.

NODIA

118. (D) Anti-freeze solution should be circulated through the pump and boom lines to prevent freeze damage
To protect spray equipment during cold months, it is essential to perform proper winterization. After thoroughly cleaning and draining the system, an anti-freeze solution should be circulated through the pump, boom lines, and nozzle bodies. This prevents any remaining water from freezing, which could otherwise cause expensive components like the pump housing or hoses to crack and fail due to ice expansion.

119. (B) Regularly checking and replacing crankcase oil and lubricating grease fittings
Plunger pumps are high-pressure, mechanical devices that require consistent lubrication to

2023

9. Silver shoots (onion leaf symptom) in rice are characteristic of infestation by which specific pest?
(A) Yellow stem borer (Scirpophaga incertulas)
(B) Rice hispa (Dicladispa armigera)
(C) Rice leaf folder (Cnaphalocrocis medinalis)
(D) Asian rice gall midge (Orseolia oryzae)

2024

10. Compared to dead hearts caused by stem borers, "flared squares" in cotton are characterized primarily by:
(A) Bracts of the fruiting body opening prematurely due to internal larval feeding.
(B) Total wilting of the main stem terminal followed by rapid drying of the square.
(C) Extensive defoliation of the bracts leaving only the central midrib structure.
(D) Formation of cup-shaped galls on the vegetative shoots near the flower buds.

2022

11. Which of the following statements correctly identifies the cause of characteristic frass extrusion in maize stems?
(A) Larvae of the Fall Armyworm construct protective webbing that traps frass externally.
(B) Stem borer (Chilo partellus) larvae eject fecal pellets through boreholes on the stalk.
(C) The aphid complex secretes honeydew which is often misidentified as frass.
(D) Grasshoppers leave large, distinct droppings exclusively on the upper canopy leaves.

2022

12. The symptom known as "dead heart" in field crops generally refers to:
(A) Necrosis of the root system leading to sudden and complete seedling collapse.
(B) Drying and death of the central shoot while older leaves remain green.
(C) Discoloration of the leaf margins due to the injection of toxic salivary enzymes.
(D) Premature dropping of floral structures before fertilization and seed set.

2016

13. Match the pest damage symptom in List I with the associated field crop pest in List II.
List I: (Pest damage symptom)
P. Silver shoot
Q. Flared squares
R. Dead heart
S. Hopper burn
List II: (Field crop pest)
1. Pink bollworm
2. Asian rice gall midge
3. Brown planthopper
4. Sorghum shoot fly
(A) P-2, Q-1, R-4, S-3
(B) P-3, Q-1, R-2, S-4
(C) P-2, Q-4, R-1, S-3
(D) P-1, Q-4, R-3, S-2

2004

14. All of the following are primary advantages of utilizing pheromone traps in pest surveillance EXCEPT:
(A) They are highly species-specific.
(B) They effectively indicate the initial arrival of adult moth flights.
(C) They physically eliminate the entire pest population from the field.
(D) They operate continuously without the need for manual field scouting.

2021

15. Which of the following surveillance indices is most appropriately used to determine the intensity of stem borer damage in a rice field?
(A) Total number of adult moths caught per standard light trap per week.
(B) Estimated number of egg masses found per square meter in the field.
(C) Presence or absence of early instar larvae in the standing water body.
(D) Percentage of tillers showing dead hearts or white ears per unit area.

2021

16. In agricultural entomology, "scouting" is best defined as:
(A) The random application of broad-spectrum insecticides across a field.
(B) The permanent eradication of a pest species using sterile insect techniques.
(C) The systematic monitoring and recording of pest population dynamics and damage.
(D) The legal quarantine process restricting the movement of agricultural commodities.

2021

17. Which of the following statements about sampling methods is INCORRECT?
(A) Absolute sampling provides an estimate of pest numbers per unit of land area.
(B) Sequential sampling requires a fixed, predetermined number of samples regardless of pest density.

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128. (C) Remove the contaminated clothing immediately and wash the affected skin thoroughly with soap and water
If concentrated pesticide is spilled on protective clothing, the immediate priority is to prevent the chemical from being absorbed through the skin. The operator must stop work, remove the contaminated coveralls immediately, and wash any affected skin areas thoroughly using plenty of soap and water. Prompt action is essential to minimize the risk of acute poisoning or long-term health effects from the exposure.

129. (B) The spiraling air masses trailing from the wingtips or rotor tips that can displace spray droplets
In aerial application, wake vortices are powerful, spiraling air currents that are generated as a byproduct of aerodynamic lift. These vortices trail behind the wingtips of fixed-wing aircraft or the rotor tips of helicopters. They can trap fine spray droplets and carry them upward and outward from the intended swath, significantly increasing the risk of off-target drift and reducing application uniformity.

130. (D) Have superior maneuverability and can treat smaller, irregularly shaped fields more effectively
Helicopters offer several operational advantages over fixed-wing aircraft for aerial pesticide application. Their superior maneuverability and ability to fly at slower speeds allow them to treat small, irregularly shaped fields or those located in difficult terrain more effectively. While they may have lower payload capacities and higher operating costs, their flexibility makes them ideal for precision work in complex agricultural landscapes.

131. (A) Increasing the height generally widens the swath but significantly increases the risk of off-target drift
The altitude at which an aircraft operates directly influences the trajectory of the spray droplets. Increasing the application height allows the spray cloud to spread further, which generally results in a wider swath width. However, this extra height also gives wind currents more time to intercept the droplets, significantly increasing the likelihood of off-target drift and reducing the accuracy of the application.

132. (C) Poor spray distribution due to the spray cloud bouncing off the crop or soil surface
Flying an aircraft extremely low, within what is known as ground effect, can negatively impact spray quality. The intense air turbulence created between the aircraft and the ground can cause the spray cloud to bounce or swirl rather than settling evenly onto the target. This results in poor distribution patterns and inconsistent coverage, which can reduce the efficacy of the pesticide application.

133. (A) The cross-track distance between successive flight lines that provides a uniform spray deposit
The effective swath width of an agricultural aircraft is the horizontal distance over which the spray is deposited uniformly during a single pass. In practice, this is the distance between successive parallel flight lines that allows the edges of the spray patterns to overlap correctly. It is not simply the length of the boom or the wingspan but a calculated operational parameter.

134. (D) Aircraft speed has no effect on atomization when using standard hydraulic nozzles
In aerial application, the forward speed of the aircraft significantly affects atomization. As the aircraft moves, the high-velocity air flowing past the nozzles shears the liquid as it exits the orifice. Faster aircraft speeds increase this shearing force, resulting in a finer droplet spectrum. Therefore, pilot speed is a critical factor in determining the final VMD of the spray cloud.

135. (B) Produce a very narrow droplet size spectrum (low VMD/NMD ratio) for ULV applications
Rotary atomizers, such as Micronairs, are widely used in aerial applications to achieve precise control over droplet size. They work by feeding liquid onto a high-speed spinning cage or disc, which throws the liquid outward to form droplets. This method produces a much narrower and more uniform droplet size spectrum compared to hydraulic nozzles, which is particularly essential for effective ULV applications.

136. (C) An electronic flow control system linked to the aircraft's GPS
Modern agricultural aircraft use electronic flow control systems that are integrated with GPS technology. These systems automatically adjust the discharge rate of the spray liquid based on the aircraft's ground speed. If the aircraft speeds up or slows down, the controller modifies the

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components ensure that a consistent volume of the volatile liquid is delivered to each shank, regardless of changes in system pressure or the tractor's ground speed.

102. (D) Fumigants require specialized injection and sealing, while granules use gravity hoppers
Soil fumigants and granules differ significantly in their application methods. Fumigants are volatile liquids that must be injected into the soil and then sealed to prevent the gas from escaping. In contrast, granular nematicides are dry solids applied using simple gravity-fed hoppers or mechanical spreaders. Granules do not require the same level of soil sealing because they release their active ingredient more slowly.

103. (B) Ensure the pesticide adheres securely to the seed coat using a water-based suspension, reducing dust-off
Slurry seed treaters use a mixture of pesticide and a small amount of water to coat seeds. This method is preferred over dry dusting because the moisture helps the chemical adhere more securely to the seed coat. This reduces "dust-off," which is the loss of pesticide during handling and planting, and ensures a more uniform and effective dose of protection for every seed.

104. (C) Increased occupational exposure risks to the operator and environmental contamination
If a dry seed treating drum is operated improperly, it can result in an excess of loose, toxic pesticide dust. This poses a significant health hazard to the operator through inhalation or dermal contact during seed handling. Additionally, the loose dust can be easily dispersed by wind during planting, leading to off-target environmental contamination and a reduction in the protective dose on the seeds.

105. (B) II and IV
Automated seed coaters are sophisticated industrial machines that operate using electrical power and advanced control systems to apply uniform layers of pesticide and polymers. They are designed for large-scale commercial use. However, they do not eliminate the need for personal protective equipment; operators must still follow safety protocols to prevent exposure to the concentrated chemicals used in the coating process.

NODIA

106. (A) Applying foliar fertilizers to mature crops
Seed treatment appliances are specialized machines designed for the early-season protection of crops by coating seeds before they are planted. Their primary functions include applying fungicides to prevent seedling diseases, insecticides to deter soil pests, and inoculating legume seeds with beneficial nitrogen-fixing bacteria. They are not intended for, and are physically incapable of, applying foliar fertilizers to mature crops in the field.

107. (B) Synchronized metering systems that link seed weight flow to the liquid discharge pump
To ensure that every seed receives the correct amount of pesticide, continuous flow slurry treaters utilize synchronized metering systems. These systems precisely measure the weight or volume of seeds flowing through the machine and automatically adjust the liquid discharge pump to match. This mechanical or electronic linkage maintains a constant ratio of chemical to seed, ensuring uniform and effective treatment of large volumes.

108. (B) Seeds and dry chemical are rotated inside a sealed baffle-equipped barrel until uniformly mixed
A dry seed treating drum is a simple mechanical device used to mix seeds with powdered pesticides. It consists of a barrel or drum, often equipped with internal baffles to improve agitation. As the drum is rotated, the seeds and the dry chemical are tumbled together, ensuring that the powder is distributed across the surface of each seed through physical contact and friction.

109. (A) Use a slurry treater or add binding polymers instead of relying strictly on dry application
Pesticide flaking off treated seeds is a common issue with dry application methods. To resolve this, the process should be adjusted by using a slurry treater or adding specialized binding polymers to the mixture. These additives help the pesticide adhere more strongly to the seed coat, preventing it from being lost during transport and planting, thus maintaining the necessary protective dose.

110. (C) P-2, Q-4, R-1, S-3
Thermal control methods use heat in various forms to manage pests. Flame throwers project an open fire blast for localized searing. Steam sterilizers inject high-temperature vapor to

suspended in the air and move unpredictably. A light, consistent breeze is preferred as it ensures a predictable direction of movement and promotes the settling of the spray.

146. (D) The evaporation potential of spray droplets and optimal spraying conditions
Delta T is a meteorological parameter calculated from the difference between dry-bulb and wet-bulb temperatures. It is widely used in aerial application to assess the evaporation potential of the atmosphere. High Delta T values indicate low humidity and high evaporation risk, which can lead to excessive droplet shrinkage and drift. Monitoring Delta T helps pilots decide when conditions are safe for spraying.

147. (A) Consistent light breeze of 8 km/h blowing away from sensitive areas
A consistent light breeze of eight kilometers per hour is actually an ideal condition for aerial application, especially when it is blowing away from sensitive non-target areas. In contrast, conditions such as severe thunderstorms, high wind speeds exceeding thirty kilometers per hour, or the presence of ground fog indicating a temperature inversion all pose significant safety and drift risks that necessitate an immediate halt.

148. (C) Treat thousands of hectares rapidly, especially when ground conditions are too wet for tractors
The most significant operational advantage of aerial application is its speed and independence from soil conditions. Aircraft can treat thousands of hectares in a very short time, which is critical for controlling rapidly spreading pests or diseases. Furthermore, they can operate when the ground is too wet or soft for heavy tractor-mounted sprayers, preventing soil compaction and ensuring timely pesticide delivery.

149. (A) The extremely high purchase, maintenance, and insurance costs of aviation equipment and pilots
While highly efficient, aerial application is limited by its immense economic costs. The purchase price of specialized agricultural aircraft, the ongoing maintenance required for aviation safety, and the high insurance premiums are substantial. Additionally, employing highly skilled pilots and ground crews adds to the expense. These factors often make aerial spraying more expensive per hectare than most ground-based application methods.

150. (D) Advantage - Does not cause mechanical damage to tall or mature crops
A major advantage of aerial application is that the equipment does not physically touch the crop. This eliminates mechanical damage and soil compaction that often occurs when tractors drive through tall or mature fields. While aerial spraying has a higher drift risk and high operating costs, its ability to treat crops without causing physical yield loss is a significant benefit for many growers.

151. (B) It inherently possesses a higher risk of large-scale off-target drift compared to ground rigs
From an environmental perspective, the primary disadvantage of aerial application is the increased potential for off-target drift. Because aircraft operate at higher speeds and altitudes than ground sprayers, the spray droplets are more exposed to wind and atmospheric turbulence. This makes it more challenging to contain the pesticide within the intended target area, increasing the risk of contaminating water bodies and sensitive crops.

152. (C) An outbreak of locusts over vast, inaccessible rangelands
Aerial application is most justified when the scale, urgency, or terrain makes ground application impossible. Controlling an outbreak of locusts over vast, inaccessible rangelands is a perfect example, as aircraft can cover enormous distances quickly and reach areas that tractors cannot. In contrast, small plots or residential areas are better served by ground equipment to minimize drift risks to the surrounding population.

153. (D) Aerial application can deploy fungicides much faster over large acreages before damage
In the face of a rapidly spreading disease like soybean rust, timeliness is the most critical factor for successful control. Aerial application is significantly faster than ground-based methods, allowing farmers to treat entire fields and large regions in a fraction of the time. This rapid response can prevent the disease from establishing and causing severe yield loss across vast acreages of vulnerable crops.

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prevent premature wear and failure. Routine maintenance must include regularly checking and replacing the oil in the crankcase and applying grease to all designated fittings. Proper lubrication reduces friction between moving parts, ensures smooth operation, and significantly extends the service life of the pistons, cylinders, and other critical internal components.

120. (C) A ruptured internal rubber diaphragm
In a diaphragm pump, the flexible diaphragm serves as a barrier that separates the spray liquid from the pump's internal mechanical parts and the oil reservoir. If this diaphragm ruptures, the pesticide mixture will leak through the tear and contaminate the oil. This failure results in a sudden loss of system pressure and is a clear indicator that the diaphragm needs immediate replacement.

121. (D) Prevent severe phytotoxic damage to susceptible crops during subsequent applications
Thoroughly cleaning a sprayer after each use is vital, especially when switching between different types of pesticides like herbicides and fungicides. Even trace amounts of certain herbicides remaining in the tank, hoses, or nozzles can cause severe phytotoxic damage to susceptible crops in the next application. Daily decontamination ensures that no chemical residues are carried over, protecting both the crop and equipment.

122. (A) Specialized clothing or equipment worn by an operator for protection against hazardous materials
Personal Protective Equipment refers to any specialized clothing or gear that an individual wears to minimize their exposure to hazardous materials, such as pesticides. This includes items like chemical-resistant gloves, aprons, goggles, and respirators. The primary purpose of PPE is to create a physical barrier between the operator and the toxic chemicals, thereby reducing the risk of acute or chronic health effects during application.

123. (B) Clearing a clogged nozzle by blowing into it directly with the mouth
Clearing a clogged nozzle by blowing into it with the mouth is an extremely dangerous practice that should never be performed. It leads to direct ingestion and inhalation of concentrated pesticide residues. Safe handling practices include wearing appropriate PPE during mixing, following all label instructions carefully, and using clean water to calibrate the sprayer. Blocked nozzles should only be cleaned using soft brushes or air.

124. (B) Acute inhalation toxicity from concentrated pesticide fumes
Thermal fogging produces microscopic droplets and vapor that remain suspended in the air. If an operator fails to wear a properly fitted respirator while fogging in an enclosed space like a greenhouse, they are at extreme risk of acute inhalation toxicity. The lungs rapidly absorb the concentrated pesticide fumes, which can lead to immediate and severe respiratory, neurological, or systemic health complications.

125. (A) Cotton gloves
When handling highly toxic organophosphates, it is essential to use chemical-resistant materials that prevent the pesticide from reaching the skin. Cotton gloves are entirely inappropriate because they are absorbent and will actually trap the chemical against the skin, increasing the risk of dermal exposure. Proper PPE for these substances includes nitrile or neoprene gloves, a chemical-resistant apron, goggles, and a suitable respirator.

NODIA

126. (C) The operator is handling the pesticide in its most concentrated form
The mixing and loading phase is the most hazardous part of the pesticide application process because the operator is handling the chemical in its pure or highly concentrated state. Splashes or spills during this stage result in a much higher dose of exposure compared to the diluted mixture in the spray tank. Consequently, strict adherence to PPE protocols is most critical during these operations.

127. (D) Dermal exposure on hands - Nitrile or neoprene gloves
Protecting the hands is vital during pesticide application because they are the most likely part of the body to come into contact with the chemical. Nitrile or neoprene gloves are specifically designed to resist chemical penetration, providing an effective barrier against dermal exposure. Other routes, such as inhalation or ocular exposure, require different specialized equipment like respirators or safety goggles, respectively.

CHAPTER 11
Pests of Field Crops and Their Management

2014

1. The lowest population density of a pest that will cause economic damage is defined as which of the following?
(A) Economic Threshold Level
(B) Economic Injury Level
(C) Damage Boundary
(D) General Equilibrium Position

2009

2. All of the following parameters are typically required to calculate the Economic Injury Level (EIL) EXCEPT:
(A) Cost of management practices per unit area
(B) Market value of the crop produce
(C) Proportion of pest population controlled by the intervention
(D) Natural enemy population density

2010

3. If the General Equilibrium Position (GEP) of a pest species is consistently maintained well below the Damage Boundary, the pest is categorized as a:
(A) Non-economic pest
(B) Key pest
(C) Occasional pest
(D) Severe pest

2007

4. The point at which measurable crop yield loss first occurs due to pest injury, independent of economic value, is known as the:
(A) Action Threshold
(B) Economic Threshold Level
(C) Damage Boundary
(D) General Equilibrium Position

2022

5. Which of the following statements regarding the Economic Threshold Level (ETL) is INCORRECT?
(A) It represents the density where damage exceeds the crop's physiological tolerance.
(B) It is synonymous with the action threshold where management measures are initiated.
(C) It is consistently positioned at a lower population density than the injury level.
(D) It provides a specific buffer period to implement controls before economic loss.

2015

6. Which scenario best justifies the application of an insecticidal treatment based on economic principles?
(A) When the pest population fluctuates slightly above the General Equilibrium Position.
(B) When the initial signs of pest feeding are observed on the lower leaves.
(C) When natural enemies are present in numbers equal to the pest population.
(D) When the pest population reaches the Economic Threshold Level and is increasing.

2003

7. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The feeding of the yellow stem borer in rice during the vegetative stage results in the manifestation of "white ears."
Reason (R): The larva severs the central shoot, depriving the developing panicle of nutrients and leading to chaffy grains.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is false but R is true.
(D) A is true but R is false.

2004

8. What is the primary physiological cause of the "hopper burn" symptom observed in rice fields?
(A) Mechanical severing of vascular tissues by chewing mouthparts during feeding.
(B) Injection of phytotoxic saliva during oviposition into the tender leaf sheath.
(C) Continuous drainage of plant sap by planthoppers leading to rapid desiccation.
(D) Transmission of the rice grassy stunt virus causing systemic plant necrosis.

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flow to ensure that a constant application rate is maintained per hectare, eliminating errors caused by variations in flight speed.

137. (D) Tractor PTO shafts
Aerial spray equipment consists of specialized components designed for aviation. These include wind-driven centrifugal pumps, trailing edge booms that minimize drag, and rotary atomizers for precise droplet control. Tractor PTO shafts are mechanical components used specifically to transfer power from a tractor's engine to ground-based implements and have no function or presence on an agricultural aircraft or its spray system.

138. (A) Utilizing the relative airflow (slipstream) past the aircraft to turn a propeller connected to the pump shaft
Many agricultural aircraft utilize a wind-driven pump to pressurize the spray system. This pump features a small propeller mounted in the aircraft's slipstream. As the aircraft flies, the relative airflow turns the propeller, which is directly connected to the pump shaft. This simple and reliable mechanism provides the necessary hydraulic pressure for the boom without requiring electrical or engine-driven power sources.

139. (B) It changes the rotational speed of the atomizer cage, thereby adjusting the droplet size
The droplet size produced by a wind-driven rotary atomizer, such as a Micronair, is determined by the rotational speed of its wire cage. By adjusting the pitch or angle of the fan blades, the pilot can control how fast the unit spins in the aircraft's slipstream. A steeper pitch increases the rotational speed, resulting in finer droplets, which allows for precise customization.

140. (B) Behind the wing's trailing edge to position nozzles in smooth airflow, reducing drag and turbulence
A trailing edge boom system is designed to mount the spray boom and nozzles behind the wing's trailing edge. This positioning is aerodynamically advantageous because it places the nozzles in a zone of relatively smooth airflow. By reducing the turbulence and drag encountered by the emerging spray, this setup helps maintain a more consistent droplet spectrum and improves the overall distribution pattern.

141. (A) Prevents the nozzle from dripping liquid during turns or when the main spray valve is shut off
Check valves, often referred to as anti-drip valves, are critical components on an aerial spray boom. They are designed to shut off the flow to the nozzle instantly when the system pressure drops below a certain threshold. This prevents the nozzles from dripping pesticide while the aircraft is turning at the end of a field or when the main valve is closed.

142. (C) It becomes trapped in a cool layer of air near the ground and can drift laterally for miles
Temperature inversions create a stable layer of air that prevents vertical mixing. If an aerial application is conducted under these conditions, the fine spray droplets will not disperse or settle normally. Instead, they become trapped in a concentrated cloud near the ground. This cloud can be carried laterally by very light winds for several miles, posing a severe risk to off-target areas.

143. (D) Low humidity increases evaporation of water-based droplets, increasing drift risk
Relative humidity significantly impacts the lifespan of a spray droplet. In low humidity environments, the water in a spray droplet evaporates rapidly as it falls through the air. As the droplet shrinks, it becomes lighter and more susceptible to being carried off-target by the wind. Consequently, spraying in dry conditions increases the risk of drift compared to more humid atmospheric conditions.

NODIA

144. (B) 4 to 15 km/h
Aerial pesticide application requires a specific range of wind speeds for safety and effectiveness. A light to moderate breeze, typically between four and fifteen kilometers per hour, is ideal. This wind speed helps to ensure that the spray cloud moves predictably and settles onto the target crop while also providing enough air movement to prevent the formation of stagnant, drift-prone clouds.

145. (B) Spraying during dead calm conditions is ideal because drift risk is entirely eliminated
Contrary to common belief, spraying during dead calm conditions is not ideal and can actually be dangerous. While wind drift is minimized, calm conditions are often associated with temperature inversions, where fine droplets can remain

(C) Relative sampling methods, such as sweep netting, do not estimate the true population density per hectare.
(D) Yellow sticky traps are typically used as a relative sampling method for flying insects.

2008

18. A farmer notices significant defoliation but cannot find any pests during the day. Based on surveillance principles, what is the most appropriate next step?
(A) Assume the pest has migrated and cease monitoring.
(B) Immediately deploy species-specific pheromone traps for planthoppers.
(C) Apply a systemic fungicide to prevent secondary infection.
(D) Conduct night-time scouting to detect nocturnal pests like cutworms.

2010

19. Consider the following statements regarding pest surveillance techniques:
I. Light traps are equally effective for capturing both diurnal and nocturnal insects.
II. Sweep net sampling is highly reliable for estimating populations of soil-dwelling larvae.
III. Pitfall traps are primarily utilized for monitoring ground-dwelling arthropods.
Which of the above statements are incorrect?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2007

20. The severe outbreak of the pink stem borer (Sesamia inferens) in wheat-rice cropping systems is primarily a consequence of:
(A) The application of selective herbicides which eliminate alternative weed hosts.
(B) The introduction of synthetic pyrethroids leading to significant pest resurgence.
(C) The pest's polyphagous nature allowing it to transition from wheat to rice.
(D) The exclusive cultivation of early-maturing rice varieties in irrigated areas.

2016

21. Which morphological characteristic differentiates the adult male yellow stem borer (Scirpophaga incertulas) from the female?
(A) The male has distinct dark spots on the forewings, which the female lacks.
(B) The male possesses a prominent tuft of anal hairs for covering egg masses.
(C) The male is wingless and remains inside the rice stem.
(D) The male lacks functional mouthparts while the female possesses them.

2018

22. The striped rice borer (Chilo suppressalis) belongs to which family of the order Lepidoptera?
(A) Noctuidae
(B) Pyralidae
(C) Gelechiidae
(D) Crambidae

2006

23. Compared to the yellow stem borer, the white stem borer (Scirpophaga innotata) is uniquely characterized by:
(A) Exclusive reliance on wheat as a primary host during the rainy monsoon season.
(B) Ability to undergo larval diapause in rice stubbles during the dry season.
(C) Habit of laying eggs singly in the field rather than in large communal masses.
(D) Preference for feeding solely on the panicle and developing grain structures.

2010

24. Which of the following statements correctly describes a cultural management strategy for rice stem borers?
(A) Maintaining deep standing water throughout the season suffocates adult moths.
(B) Applying high doses of nitrogenous fertilizers thickens the stalk, preventing larval entry.
(C) Clipping the seedling tips before transplanting reduces the carryover of borer eggs.
(D) Planting susceptible varieties as a main crop traps the early larval instars.

2024

25. Consider the following statements regarding the bionomics of rice stem borers:
I. Yellow stem borer is a monophagous pest strictly dependent on rice.
II. Larvae of the pink stem borer construct a protective case from rice leaves.
III. White stem borer outbreaks are closely associated with distinct dry and wet seasons.
IV. Stem borer larvae pupate entirely within the soil matrix.
Which of the above statements are correct?
(A) I and III
(B) II, III and IV

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(C) I, II and IV
(D) I and IV

2013

26. All of the management practices are recommended for mitigating Brown Plant Hopper (BPH) outbreaks in rice EXCEPT:
(A) Indiscriminate early-season application of broad-spectrum insecticides.
(B) Practicing alternate wetting and drying of the field to reduce moisture.
(C) Establishing alleyways of 30 cm for every 2-3 meters of planting distance.
(D) Utilizing resistant rice varieties such as IR36 or IR64 in endemic areas.

2025

27. Which of the following describes the most damaging stage and mode of feeding of the Gundhi bug (Leptocorisa oratorius) in rice?
(A) The adults and nymphs cause severe defoliation during the tillering stage.
(B) Both adults and nymphs extract milky sap from developing grains.
(C) Only the nymphs burrow into the stem, causing dead hearts.
(D) The adult females oviposit into the roots, leading to plant collapse.

2021

28. "Hopperburn" in rice is a characteristic physiological disorder caused by:
(A) Toxic effect of fungicides applied during the booting stage of the crop.
(B) Depletion of plant sap and damage to vascular tissues by planthoppers.
(C) Mechanical scraping of leaf epidermal layers by adult rice hispa beetles.
(D) Systemic infection by the rice tungro virus causing physiological stress.

2005

29. Which of the following statements concerning the Green Leafhopper (Nephotettix virescens) is INCORRECT?
(A) The adults prefer to feed on the basal portion of the stem near the water level.
(B) It acts as the primary vector for the Rice Tungro Virus disease complex.
(C) They exhibit strong positive phototaxis, making light traps effective tools.
(D) Egg masses are inserted into the midribs or leaf sheaths of the rice plant.

2009

30. A rice field exhibits circular patches of completely dried, brownish plants that are rapidly expanding. An examination of the basal stems reveals large numbers of small, brownish, highly mobile insects. What is the most appropriate immediate action?
(A) Apply an insecticide specifically targeted at the rice stem borer population.
(B) Broadcast urea to stimulate rapid and healthy compensatory plant growth.
(C) Drain the field of standing water to alter the microclimate at the base.
(D) Install pheromone traps to capture adult gall midges throughout the field.

NODIA

2007

31. Consider the following statements regarding sap-sucking pests of rice:
I. Brown Plant Hopper (BPH) causes hopperburn but does not transmit any known viral diseases.
II. Gundhi bug infestations are most severe during the vegetative growth phase.
III. Green Leafhoppers lay their eggs in distinct masses covered with anal hairs.
IV. BPH populations often exhibit resurgence following the application of certain synthetic pyrethroids.
V. The economic threshold level for Gundhi bug is generally 1-2 bugs per hill.
Which of the above statements are incorrect?
(A) I, II and IV
(B) II, III and V
(C) I, II and III
(D) III, IV and V

2004

32. The primary damage caused by the rice root aphid (Tetraneura nigriabdominalis) typically results in:
(A) Silvering of the emerging leaves near the tip.
(B) Extensive chaffy grains found during the harvest.
(C) Stunted growth and yellowing due to sap extraction.
(D) Feeding scars on the lemma and palea of the seeds.

2001

33. An outbreak of the wheat aphid complex during the ear-head stage is most likely to cause which of the following physiological effects?
(A) Complete failure of the seminal root system due to physiological shock.

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(B) Reduction in grain weight and impairment of grain filling due to sap loss.
(C) Formation of prominent galls on the peduncle causing sterility in grains.
(D) Rapid defoliation leaving only the midribs of the flag leaf after feeding.

2023

34. The Gujhia weevil (Tanymecus indicus), an important pest of wheat, is functionally classified based on its feeding habits as a:
(A) Leaf-mining insect
(B) Strictly monophagous panicle feeder
(C) Phloem-feeding vector of viral diseases
(D) Polyphagous soil-dwelling seedling pest

2003

35. When comparing the damage caused by the wheat armyworm (Mythimna separata) to that of wheat aphids, which feature is unique to the armyworm?
(A) Complete severing of the ear-heads from the peduncle at maturity.
(B) Secretion of honeydew leading to the growth of black sooty mold.
(C) Transmission of the Barley Yellow Dwarf Virus during the season.
(D) Continuous sap extraction from the developing grain in the head.

2018

36. Which of the following correctly describes the overwintering strategy of the wheat aphid (Sitobion avenae) in temperate Indian conditions?
(A) Burrows into the soil and constructs a protective pupal cell.
(B) Migrates to alternate leguminous hosts to undergo aestivation.
(C) Survives on alternate graminaceous hosts or volunteer plants.
(D) Enters a true larval diapause within the hollow wheat stubbles.

2005

37. Select the correct order of sequence for the typical life cycle stages of the Gujhia weevil (Tanymecus indicus) beginning from the overwintering stage.
(A) Overwintering pupa → Adult emergence → Egg laying → Grub feeding
(B) Overwintering egg → Grub feeding → Pupation → Adult emergence
(C) Overwintering adult → Egg laying → Grub feeding → Pupation
(D) Overwintering grub → Pupation → Adult emergence → Egg laying

2007

38. All of the following are primary management strategies for controlling the wheat armyworm (Mythimna separata) EXCEPT:
(A) Spraying insecticides during the late evening hours.
(B) Deep summer ploughing to expose pupae to birds and desiccation.
(C) Utilizing localized poison baits around the field margins.
(D) Flooding the field during the seedling stage to suffocate the larvae.

2021

39. Which biological attribute makes the Fall Armyworm (Spodoptera frugiperda) particularly difficult to manage in maize crops?
(A) It strictly feeds only on the fully mature tassels during the season.
(B) The larvae conceal themselves deep within the protective plant whorl.
(C) It has a very slow reproductive cycle, masking rapid population buildup.
(D) The adult moths are flightless and remain confined to the lower canopy.

2010

40. The term "dead heart" in sorghum, caused by the shoot fly (Atherigona soccata), refers to:
(A) The necrosis of the root radical post-germination after planting.
(B) The failure of the panicle to emerge from the protective boot leaf.
(C) The drying of the central leaf due to larval feeding at the point.
(D) The hollowed-out stem interior containing distinct fecal frass pellets.

NODIA

2007

41. Which of the following statements about the spotted stem borer (Chilo partellus) is INCORRECT?
(A) It attacks both maize and sorghum.
(B) The primary symptom of damage during the vegetative stage is the production of characteristic "shot-holes" on leaves.
(C) Intercropping maize with non-host legumes can reduce its incidence.
(D) It undergoes diapause as a pupa within the soil during the winter season.

2015

42. A sorghum field planted very late in the Kharif season is exhibiting high levels of central shoot drying in 2-week-old seedlings. The most likely

2003

75. A groundnut crop is exhibiting widespread stunted growth, and the terminal buds are necrotic. Upon closer inspection, tiny, slender, fringed-wing insects are found in the flowers. The most effective IPM strategy would be:
(A) Flooding the field to eliminate pupae.
(B) Using sticky traps and systemic sprays.
(C) Immediate application of soil fumigants.
(D) Releasing Trichogramma egg parasitoids.

2023

76. The symptom commonly referred to as "hopperburn" in groundnut is caused primarily by the toxic saliva of:
(A) Aproaerema modicella (Leaf miner)
(B) Empoasca kerri (Jassids)
(C) Aphis craccivora (Aphid)
(D) Odontotermes obesus (Termites)

2019

77. Which of the following statements concerning the management of the groundnut leaf miner is INCORRECT?
(A) Application of broad-spectrum contact insecticides is most effective when the larvae are fully enclosed within the leaf mines.
(B) Setting up light traps helps in monitoring and mass trapping of adult moths.
(C) Avoiding water stress through timely irrigation can significantly reduce the severity of the infestation.
(D) Conservation of natural enemies like parasitoids (e.g., Goniozus spp.) plays a vital role in its natural control.

2017

78. In sunflower cultivation, extensive damage to the developing seeds and the presence of frass webbing over the floral face is most definitively caused by:
(A) Safflower aphid draining sap from the stem.
(B) Til leaf webber binding leaves and flowers.
(C) Capitulum borer feeding on the floral face.
(D) Sunflower defoliator consuming leaf tissue.

2021

79. Select the correct sequential order of the life cycle events for the Til (sesame) leaf webber and gall fly (Antigastra catalaunalis).
(A) Egg → Larval webbing/feeding → Pupation in soil → Adult emergence
(B) Egg → Larval webbing/feeding → Pupation within webbed leaves → Adult emergence
(C) Egg → Pupation in soil → Larval feeding → Adult emergence
(D) Adult emergence → Pupation → Egg → Larval webbing

2014

80. The safflower aphid (Uroleucon carthami) typically causes severe economic loss by:
(A) Tunneling into the main stalk causing the plant to snap.
(B) Biting and chewing the floral bracts causing head drop.
(C) Draining sap from leaves and stems causing poor growth.
(D) Cutting the seedlings at the soil surface during night.

2009

81. Heavy and unseasonal rainfall during the early vegetative stage of sesame is likely to result in which of the following ecological effects on the gall fly (Asphondylia sesami)?
(A) Massive outbreak due to rapid stimulation of the diapause eggs.
(B) Suppression of the population due to washing away of adults.
(C) An induced shift in feeding preference from flowers to roots.
(D) The emergence of a flightless morph of the adult fly species.

2015

82. Based on the site of damage, how does the capitulum borer differ from the til leaf webber?
(A) Borer targets the root system, while the webber targets seeds.
(B) Borer attacks the floral head, while webber attacks foliage.
(C) Borer mines the stem, while the webber induces root galls.
(D) Borer is a sap sucker, while the webber is a chewing insect.

2021

83. When analyzing the management of safflower aphids, which characteristic represents a distinct advantage of utilizing boundary cropping with a tall cereal like sorghum?
(A) Provides a physical barrier that intercepts migrant aphids.
(B) Chemically neutralizes the aphid alarm pheromone signal.
(C) Acts as a highly preferred alternate food source for pests.
(D) Desiccates the soil creating poor conditions for pupation.

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(C) A is true but R is false.
(D) A is false but R is true.

2004

50. All of the following are recognized components of an integrated pest management (IPM) module for the Gram Pod Borer EXCEPT:
(A) Application of HaNPV against early larval instars.
(B) Erection of bird perches to encourage predation.
(C) Deep summer ploughing to expose overwintering pupae.
(D) Planting susceptible trap crops to host the pest.

2005

51. In a multi-cropping system involving cotton, pigeonpea, and chickpea, which approach constitutes the BEST long-term strategy for managing Helicoverpa armigera?
(A) Integrating crop rotation, resistance, and biopesticide use.
(B) Applying a single class of pyrethroids across all crop systems.
(C) Eradicating all leguminous crops to break the pest's cycle.
(D) Delaying the sowing of all crops to avoid peak moth flights.

2005

52. The characteristic diagnostic symptom of damage by the Tur pod fly (Melanagromyza obtusa) in pigeonpea is:
(A) The presence of webbing and frass binding multiple pods.
(B) Complete desiccation of the pod without any exit holes.
(C) Exit holes on mature pods and partially eaten grains.
(D) Severe defoliation leading to bare floral branches.

2018

53. Which of the following statements regarding the spotted pod borer (Maruca vitrata) is INCORRECT?
(A) It is a major pest restricted exclusively to the post-harvest storage phase of pigeonpea.
(B) The larvae characteristically web together flowers, leaves, and pods.
(C) The adult moth has distinct translucent white patches on its forewings.
(D) Damage often leads to the shedding of flowers and significant yield reduction.

NODIA

2025

54. A pigeonpea crop exhibits shriveled pods with small dark puncture marks. Upon shaking the plants, several brownish-green, shield-shaped insects emit a strong, foul odor. This damage is most likely caused by:
(A) The plume moth (Exelastis atomosa)
(B) The tur pod fly (Melanagromyza obtusa)
(C) The gram pod borer (Helicoverpa armigera)
(D) The pod bug (Clavigralla gibbosa)

2018

55. Match the pigeonpea pest in List I with its characteristic feature or damage in List II.
List I: (Pigeonpea pest)
P. Tur pod fly
Q. Spotted pod borer
R. Plume moth
S. Pod bug
List II: (Characteristic feature or damage)
1. Sap sucking leading to shriveled grains
2. Larva is hairy, feeds on developing seeds, and mimics the pod surface
3. Hidden internal feeding, pupation inside the pod
4. Webbing of floral parts and pods
(A) P-3, Q-4, R-2, S-1
(B) P-4, Q-3, R-1, S-2
(C) P-3, Q-4, R-2, S-1
(D) P-2, Q-1, R-4, S-3

2007

56. The larva of the plume moth (Exelastis atomosa) attacking pigeonpea is easily distinguishable in the field by:
(A) Its bright red head and completely smooth and hairless body.
(B) Its habit of burrowing into the main stem to remain hidden.
(C) Being covered with spines and feeding externally on pods.
(D) Construction of a tough silken cocoon on the leaf surface.

2016

57. What is the primary reason the Tur pod fly (Melanagromyza obtusa) is particularly difficult to control with standard contact insecticides?
(A) Adults migrate vast distances immediately after oviposition.
(B) Insect possesses a heavily sclerotized cuticle for protection.
(C) Eggs are laid deep within the root nodules of the host plant.
(D) Larval and pupal development occurs

concealed within the pod.

2002

58. Based on its site of damage, which of the following pigeonpea pests represents a distinct classification from the others?
(A) Clavigralla gibbosa
(B) Melanagromyza obtusa
(C) Maruca vitrata
(D) Exelastis atomosa

2002

59. Compared to the stem fly (Ophiomyia phaseoli) damage, the damage caused by the galerucid beetle (Madurasia obscurella) on moong bean is characterized by:
(A) Extensive tunneling within the main stem leading to plant collapse.
(B) Small, circular shot-holes on the foliage of young seedlings.
(C) Transmission of the Yellow Mosaic Virus.
(D) Complete consumption of the developing pods.

2023

60. Which of the following correctly identifies the role of the whitefly (Bemisia tabaci) in moong and urd bean cultivation?
(A) Primary mechanical vector for bacterial leaf blight.
(B) Principal vector for the Yellow Mosaic Virus (MYMV).
(C) Bores into the stem causing distinct dead hearts.
(D) Causes significant root-knot formations in legumes.

2025

61. Consider the following statements regarding the pests of cowpea and moong bean:
I. Thrips are known to transmit the Groundnut Bud Necrosis Virus to cowpea.
II. The stem fly causes severe seedling mortality by tunneling into the cortical tissue.
III. The galerucid beetle is a strict phloem feeder causing hopperburn.
Which of the above statements are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2009

62. All of the following are standard cultural control practices for managing the whitefly population in moong bean EXCEPT:
(A) Early and synchronized sowing of the crop.
(B) Weed management to remove alternate hosts.
(C) Frequent irrigation to drown the whiteflies.
(D) Utilization of resistant or tolerant varieties.

2013

63. The most effective diagnostic method to confirm stem fly (Ophiomyia phaseoli) infestation in a wilting cowpea seedling is to:
(A) Check the leaves for sticky honeydew secretions.
(B) Examine the flowers for deformed stamen parts.
(C) Shake the plant to observe any dislodged adults.
(D) Split the stem to observe internal red tunnels.

2002

64. Thrips infestation in moong bean primarily results in which of the following specific floral symptoms?
(A) Excessive production of sterile pollen grains.
(B) Hypertrophy of petals leading to giant flowers.
(C) Deformed flowers that drop prematurely.
(D) Complete abscission of the pedicel before budding.

2025

65. Which of the following statements about the mustard aphid (Lipaphis erysimi) is INCORRECT?
(A) Infestations are generally most severe during cloudy, humid weather.
(B) The pest exclusively reproduces sexually throughout its life cycle in Indian plains.
(C) It causes curling, yellowing, and drying of leaves due to sap extraction.
(D) The secretion of honeydew promotes the growth of black sooty mold.

2008

66. A mustard field shows young seedlings drying up rapidly. Upon inspection, dark-colored, flat insects with distinct red and black markings are observed congregating on the stems and leaves. What pest is causing this damage?
(A) Mustard sawfly
(B) Mustard aphid
(C) Diamondback moth
(D) Painted bug

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2022

67. Consider the following statements regarding the bionomics of rapeseed-mustard pests:

I. The painted bug (Bagrada hilaris) nymphs and adults suck sap from leaves and pods.

II. The mustard sawfly (Athalia lugens proxima) belongs to the order Lepidoptera.

III. Mustard sawfly larvae possess a distinct biological habit of curling up and dropping when disturbed.

IV. Mustard aphid populations typically peak during the late summer months.

Which of the above statements are correct?

(A) I and III
(B) II and IV
(C) I and III
(D) III and IV

2003

68. The larval stage of the mustard sawfly (Athalia lugens proxima) is morphologically characterized by having:

(A) No visible legs appearing completely maggot-like.
(B) Three pairs of thoracic legs and no abdominal prolegs.
(C) Three thoracic and six to eight pairs of prolegs.
(D) Three thoracic and up to four pairs of prolegs.

2005

69. Early sowing of rapeseed-mustard (before October 15 in northern India) is an effective cultural strategy primarily because it:

(A) Escaping peak incidence of the mustard aphid.
(B) Preventing the germination of parasitic weeds.
(C) Ensuring harvest before the sawfly emergence.
(D) Inducing resistance to the diamondback moth.

2024

70. Based on taxonomic classification, which of the following mustard pests does NOT belong to the class Insecta, order Hemiptera?

(A) Painted bug
(B) Mustard aphid
(C) Cabbage bug
(D) Mustard sawfly

2001

71. When comparing the feeding damage on mustard seedlings, how does the sawfly differ from the painted bug?

(A) Sawfly induces root galls while the bug feeds on the pods.
(B) Sawfly larva chews leaves while the bug sucks plant sap.
(C) Sawfly feeds as a stem borer while the bug mines leaves.
(D) Sawfly causes hopperburn while the bug causes defoliation.

2011

72. Which of the following is an accurate description of the damage caused by the groundnut leaf miner (Aproaerema modicella)?

(A) Early instars construct webs tying branches.
(B) Adult beetles bore into the developing pegs.
(C) Larvae mine the leaflets producing blisters.
(D) Sap extraction leading to a rosette condition.

2021

73. Consider the following statements regarding groundnut pests:

I. Tobacco caterpillar (Spodoptera litura) acts as a severe defoliator in groundnut.

II. Thrips (Scirtothrips dorsalis) are the primary vector for Groundnut Bud Necrosis Virus.

III. Groundnut leaf miner damage is usually more severe during periods of heavy, continuous rainfall.

IV. Jassids cause characteristic V-shaped yellowing at the leaf tips.

V. White grubs damage groundnut primarily by severing the roots below the soil surface.

Which of the above statements are INCORRECT?

(A) I, II and IV
(B) III only
(C) II, IV and V
(D) I, III and V

2017

74. All of the following are behavioral characteristics of the tobacco caterpillar (Spodoptera litura) on groundnut EXCEPT:

(A) The larvae strictly confine their feeding to the root nodules underground.
(B) Early instar larvae feed gregariously on the epidermal leaf tissue.
(C) Mature larvae disperse and feed solitarily, consuming entire leaves.
(D) The adult female lays eggs in prominent masses covered with brown scales.

NODIA

causal pest and appropriate mitigation strategy for future seasons would be:
(A) Sorghum shoot fly; advance the sowing date to early monsoon.
(B) Fall armyworm; increase the use of synthetic pyrethroids.
(C) Sorghum midge; alter the flowering synchronization.
(D) Spotted stem borer; apply soil systemic nematicides.

2018

43. Arrange the chronological sequence of damage symptoms produced by the Fall Armyworm (Spodoptera frugiperda) on maize as the crop matures.
I. Complete destruction of the whorl leaves and tassel
II. Window-pane damage on tender leaves
III. Direct feeding on the developing ears and kernels
IV. Elongated papery patches and small holes
(A) II, IV, I, III
(B) IV, II, III, I
(C) II, I, IV, III
(D) I, II, IV, III

2017

44. The eggs of the sorghum shoot fly (Atherigona soccata) are typically characterized by being laid:
(A) In large communal masses covered with brown anal hairs on the main stem.
(B) Singly on the lower leaf surface, usually parallel to the leaf midrib.
(C) Deeply inserted into the whorl using a specialized elongated ovipositor.
(D) Loose in the soil near the base of the plant during the seedling stage.

2010

45. What is the ecological consequence of the Fall Armyworm's (Spodoptera frugiperda) lack of diapause behavior?
(A) It must migrate and rely on overlapping hosts for continuous generations.
(B) It restricts the pest exclusively to high-altitude temperate climate zones.
(C) It causes the population to completely collapse during any mild winters.
(D) It limits the pest to a single generation per year in tropical climates.

2005

46. Based on its host range and feeding behavior, the Gram Pod Borer (Helicoverpa armigera) is classified as a:
(A) Monophagous foliage feeder restricted to few hosts.
(B) Oligophagous sap-sucking pest of floral branches.
(C) Polyphagous pest of reproductive plant structures.
(D) Highly specialized root-boring insect of legumes.

2013

47. When comparing the damage caused by Helicoverpa armigera on cotton versus chickpea, which of the following highlights the behavioral difference?
(A) On cotton, it strictly acts as a leaf-miner, while on chickpea, it feeds on roots.
(B) On cotton, it acts as a virus vector, while on chickpea, it causes mechanical damage.
(C) On cotton, it feeds entirely at night, whereas on chickpea, it is strictly diurnal.
(D) On cotton, it causes flared squares, while on chickpea, it bores into the pods.

2011

48. Which of the following statements correctly identifies a key biological attribute contributing to the severe pest status of Helicoverpa armigera?
(A) Species has remarkably low fecundity but a very high survival rate.
(B) Relies on a single specific sex pheromone making trapping very easy.
(C) Possesses a high propensity to develop resistance to many chemicals.
(D) Larvae exhibit a strong tendency toward cannibalism within the pod.

2025

49. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Planting a few rows of marigold (Tagetes spp.) alongside tomato or chickpea fields is a recommended management practice for Helicoverpa armigera.
Reason (R): Marigold acts as a trap crop because adult female moths prefer to lay their eggs on its prominent flowers.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.

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2021

84. Which of the following statements CORRECTLY defines the specific damage symptom known as "rosette flowers" in cotton?
(A) Premature yellowing and crinkling of leaves from whitefly.
(B) Proliferation of vegetative shoots due to jassid feeding.
(C) Flowers failing to open properly due to pink bollworms.
(D) Bolls failing to open due to accumulation of sooty mold.

2012

85. Determine the correct sequential arrangement of the life cycle phases of the Pink Bollworm (Pectinophora gossypiella) in northern Indian cotton zones.
I. Pupation in soil or leaf litter
II. Larval diapause inside double seeds (seed cotton)
III. Emergence of adult moths during early monsoon
IV. Active larval feeding inside developing bolls
(A) III, IV, I, II
(B) III, IV, II, I
(C) I, II, III, IV
(D) II, III, IV, I

2024

86. All of the following are distinguishing features of the damage caused by the spotted bollworm (Earias spp.) on cotton EXCEPT:
(A) Early-season attack results in the drying and drooping of terminal shoots.
(B) Later-season attack involves boring into squares and bolls.
(C) Damaged bolls often show distinct boreholes blocked with excreta.
(D) The larvae construct prominent protective silken webs across the leaf canopy.

2013

87. The widespread adoption of transgenic Bt cotton in India primarily targeted which of the following specific pest complexes?
(A) The sap-sucking complex like whiteflies and aphids.
(B) The bollworm complex of American and pink species.
(C) The subterranean pest complex of termites and grubs.
(D) The defoliator complex of Spodoptera and loopers.

2004

88. In the context of managing resistance to Bt cotton, what is the fundamental purpose of planting "refuge" crops?
(A) To provide a natural habitat for predators.
(B) To act as a trap crop that kills adult moths.
(C) To produce susceptible pests for mating.
(D) To deplete soil nutrients for borer pupae.

2008

89. Which of the following statements about the diapause behavior of the cotton bollworm complex is INCORRECT?
(A) American bollworm undergoes diapause as a pupa in the soil.
(B) Pink bollworm undergoes a larval diapause during the winter.
(C) Spotted bollworm requires an adult diapause in the summer.
(D) Destroying residues disrupts the pink bollworm diapause.

NODIA

2002

90. A cotton farmer observes large holes in the bolls, with the anterior half of a heavily striped, hairy larva inside and its posterior half outside. This specific feeding posture and morphology is diagnostic of:
(A) Helicoverpa armigera (American bollworm)
(B) Pectinophora gossypiella (Pink bollworm)
(C) Earias vittella (Spotted bollworm)
(D) Spodoptera litura (Tobacco caterpillar)

2016

91. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The cotton whitefly (Bemisia tabaci) is considered a critical economic pest not solely due to direct sap extraction, but largely because of its role as a vector.
Reason (R): It transmits the Cotton Leaf Curl Virus (CLCuV), which causes severe stunting, leaf curling, and enations on the veins.
(A) Both A and R are true but R is not the correct explanation of A.
(B) A is true but R is false.
(C) Both A and R are true and R is the correct explanation of A.
(D) A is false but R is true.

2002

92. The occurrence of a severe sticky cotton problem, where the lint becomes contaminated and difficult to process, is primarily attributed to heavy infestations of:

(A) Thrips and jassids
(B) Mealybugs and whiteflies
(C) Bollworms and stem weevils
(D) Spider mites and leaf rollers

2011

93. A sudden and dramatic resurgence of the cotton mealybug (Phenacoccus solenopsis) is most frequently an induced ecological effect of:
(A) Repeated application of sprays that kill natural enemies.
(B) Incorporation of high doses of potash fertilizer in soil.
(C) Intercropping cotton with resistant varieties of sorghum.
(D) Widespread use of sex pheromone mating disruption tools.

2013

94. Based on damage symptomatology, the downward curling and crinkling of cotton leaves is most distinctly associated with feeding by:
(A) Thrips feeding on leaves.
(B) Aphids extracting sap.
(C) Jassids feeding on sap.
(D) Whiteflies on foliage.

2021

95. When comparing the symptoms of jassid attack to those of thrips attack on cotton foliage, which of the following is correct?
(A) Jassids cause defoliation, whereas thrips induce galling.
(B) Jassids secrete honeydew, whereas thrips spin fine webs.
(C) Jassids feed on floral parts, whereas thrips feed on roots.
(D) Jassids cause yellowing, whereas thrips cause silvering.

2010

96. Which of the following cultural practices correctly contributes to the integrated management of the cotton sap-sucking pest complex?
(A) High-density planting to increase canopy humidity.
(B) Excessive nitrogen to promote succulent growth.
(C) Destruction of alternate weed hosts off-season.
(D) Delayed sowing to coincide with peak migration.

2023

97. Match the major pest of jute and mesta in List I with its corresponding primary damage mechanism in List II.
List I: (Pest of jute and mesta)
P. Jute semilooper
Q. Stem weevil
R. Bihar hairy caterpillar
S. Mealybug
List II: (Primary damage mechanism)
1. Skeletonization of leaves, highly polyphagous
2. Boring into the stem leading to node formation and loss of fiber quality
3. Defoliation, specifically moving in a looping manner
4. Sap extraction causing severe stunting of the apical shoot
(A) P-3, Q-2, R-1, S-4
(B) P-2, Q-3, R-4, S-1
(C) P-1, Q-4, R-2, S-3
(D) P-4, Q-1, R-3, S-2

2007

98. All of the following are true regarding the jute stem weevil (Apion corchori) EXCEPT:
(A) The female excavates a small hole in the stem for oviposition.
(B) The resulting grub damage causes the plant to form a hard gall or knot.
(C) The damage significantly reduces the tensile strength and quality of the extracted fiber.
(D) It acts as the primary vector for the Jute Mosaic Virus.

2013

99. The most critical management intervention for the Bihar hairy caterpillar (Spilosoma obliqua) in jute should target which specific life stage and behavior?
(A) Early-instar larvae that feed gregariously on leaves.
(B) The highly mobile and high-flying adult moth stage.
(C) Solitary and deeply burrowing late-instar larvae.
(D) The pupae that attach securely to the upper canopy.

2025

100. The term "semilooper" applied to the jute pest Anomis sabulifera refers anatomically to the fact that the larva:
(A) Lacks a distinct head capsule and moves by contracting.
(B) Possesses fully developed wings in the larval

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stage.
(C) Lacks abdominal prolegs causing it to arch its body.
(D) Constructs a semi-circular silken tent for protection.

2011

101. Identify the INCORRECT statement regarding the management of jute pests.
(A) Early planting of jute often helps the crop escape the peak damage of the jute semilooper.
(B) Placing bird perches in the field is entirely ineffective for managing the Bihar hairy caterpillar.
(C) Uprooting and destroying stubbles post-harvest reduces the carryover of the stem weevil.
(D) Dragging a rope coated with kerosene across the crop canopy can dislodge semilooper larvae.

2014

102. The localized formation of hard, woody knots on the main stem of the jute plant is a direct physiological response to:
(A) Toxic saliva injected by sap-sucking mealybugs.
(B) Systemic fungal infection from semilooper feeding.
(C) Mechanical damage caused by sweeping field winds.
(D) Tissue injury and larval feeding by beetle grubs.

2010

103. Consider the following statements concerning the jute stem weevil (Apion corchori):
I. The adult is a small, dark-colored weevil with a prominent snout.
II. The damage is restricted exclusively to the seedling stage of the crop.
III. The pupal stage is completed entirely inside the stem of the jute plant.
Which of the above statements are correct?
(A) I and III
(B) II and III
(C) I and III
(D) I, II and III

2004

104. The early shoot borer of sugarcane (Chilo infuscatellus) primarily causes maximum economic damage during which growth stage of the crop?
(A) The grand growth phase of the crop lifecycle.
(B) The late flowering and tasseling phase stage.
(C) The pre-monsoon tillering phase of the plant.
(D) The ripening and maturity phase before harvest.

2010

105. A characteristic symptom of top borer (Scirpophaga excerptalis) attack in sugarcane is the manifestation of:
(A) Reddening of internodes and an alcoholic smell.
(B) Yellowing of lower leaves leading to drying.
(C) Deep trenches along the outer rind of the cane.
(D) A dead heart with a bunchy top plant appearance.

2001

106. Based on the site of damage, which sugarcane borer is most likely to reduce the quality of the setts used for propagation without necessarily killing the entire cane?
(A) Internode borer damaging the quality of the setts.
(B) Root borer causing death of the root system.
(C) Top borer attacking the apical growing point.
(D) Early shoot borer killing the young tillers.

2012

107. When comparing the symptoms of the early shoot borer to the root borer in sugarcane, what is the primary diagnostic difference in the dead heart produced?
(A) ESB dead heart is hard to pull while root borer pulls easily.
(B) ESB dead heart pulls easily while root borer does not.
(C) ESB causes blackening while root borer causes purple leaves.
(D) ESB affects only tillers while root borer affects the shoot.

2025

108. Which of the following is a CORRECT cultural management practice recommended specifically for mitigating the internode borer in sugarcane?
(A) Detrashing of the dry lower leaves regularly.
(B) Frequent irrigation to keep topsoil saturated.
(C) Early planting during the peak winter season.
(D) Applying high doses of nitrogen until harvest.

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2015

159. The mathematical concept underlying the calculation of the Economic Injury Level (EIL) in pest management is best described as:

(A) The point where the pest is eradicated from the site.

(B) The density at which natural predators are sure to fail.

(C) The mathematical average of pest populations over time.

(D) The pest density where control cost equals value saved.

2010

160. Botanical insecticides, such as Azadirachtin extracted from the neem tree, function in an IPM program primarily by acting as:

(A) An instantaneous and highly toxic contact nerve poison.

(B) A synthetic attractant used in standard trapping devices.

(C) An antifeedant, growth regulator, and deterrent.

(D) A broad-spectrum fumigant that sterilizes the field soil.

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NODIA

2010

117. The severe economic damage caused by the tobacco caterpillar (Spodoptera litura) in tobacco nurseries and main fields is primarily a direct result of:
(A) Extensive defoliation leaving only the midribs.
(B) Transmission of the Tobacco Mosaic Virus pathogen.
(C) Deep tunneling into the stem causing lodging.
(D) Root pruning leading to rapid wilting during day.

2024

118. Which morphological or behavioral trait is used to classify the aphid Myzus persicae as a critical threat to tobacco cultivation?
(A) Its status as a solitary ground predator.
(B) Robust mandibles for chewing leaf margins.
(C) Preference for feeding on yellowed leaves.
(D) Efficiency in vectoring tobacco viruses.

2014

119. When comparing the feeding locations of the tobacco stem borer (Scrobipalpa heliopa) and Spodoptera litura on tobacco, what is the primary difference?
(A) The stem borer feeds on the roots, while Spodoptera feeds on the flowers.
(B) The stem borer causes internal galling and swelling of the stem, whereas Spodoptera causes massive external defoliation.
(C) The stem borer attacks post-harvest stored leaves, while Spodoptera attacks the field crop.
(D) The stem borer feeds entirely at night on the leaf margins, whereas Spodoptera mines the leaf veins during the day.

2012

120. Which of the following correctly identifies an effective IPM practice for managing Spodoptera litura in tobacco?
(A) Sowing nursery beds densely to provide a canopy.
(B) Applying heavy irrigation to drown the pupae.
(C) Using castor as a trap crop around the field.
(D) Eradicating all trap crops to starve the pest.

2019

121. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The application of entomopathogenic fungi or viruses like SlNPV is often most effective against the early instars of Spodoptera litura.
Reason (R): Early instars feed gregariously and have a thinner cuticle, facilitating rapid horizontal transmission and infection before they disperse.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2004

122. All of the following are characteristics of the tobacco stem borer (Scrobipalpa heliopa) EXCEPT:
(A) It is a highly polyphagous pest that prefers grasses over solanaceous crops.
(B) The larvae bore into the midribs and subsequently enter the stem.
(C) The damage leads to characteristic stunting and formation of a “rosette” appearance.
(D) Uprooting and burning of infested seedlings is a primary control measure.

2019

123. During a locust warning scenario, which biological phenomenon triggers the transformation of the Desert Locust (Schistocerca gregaria) from the solitary phase to the gregarious phase?
(A) Sudden extreme drop in ambient temperature and frost.
(B) Physical crowding and tactile stimulation of nymphs.
(C) Complete starvation due to severe drought conditions.
(D) Absence of mating opportunities in an isolated pocket.

2004

124. The fundamental mechanism responsible for the phase polymorphism observed in locusts is driven by changes in:
(A) The complete restructuring of the chromosome number.
(B) Changes in serotonin and juvenile hormone dynamics.
(C) The genetic sequence of the mitochondrial DNA code.
(D) Infection by a symbiotic endobacteria in the gut.

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2018

125. Which of the following statements regarding locust species in India is INCORRECT?
(A) The Migratory Locust (Locusta migratoria) is entirely extinct and has not been recorded in India for over a century.
(B) The Desert Locust primarily breeds in the arid regions of Rajasthan and Gujarat.
(C) The Bombay Locust (Nomadacris succincta) typically has only one generation per year.
(D) Gregarious desert locust adults differ in color (often yellow/pink) compared to solitary adults.

2023

126. A massive swarm of desert locusts is approaching a major agricultural zone. What is the most effective and operationally viable method for immediate swarm management?
(A) Deploying mass pheromone traps to capture adult males.
(B) Broadcasting granular systemic insecticides into soil.
(C) Aerial application of ULV insecticides onto swarms.
(D) Releasing laboratory-reared egg parasitoids in path.

2025

127. Match the term related to locust biology in List I with its correct description in List II.
List I: (Term related to locust biology)
P. Solitaria
Q. Gregaria
R. Hopper bands
S. Fledgling
List II: (Description)
1. Cohesive groups of marching, wingless nymphs
2. A newly molted adult locust with soft wings
3. The phase characterized by individualistic behavior and cryptic coloration
4. The highly active, swarming phase with distinct coloration
(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-3, Q-4, R-2, S-1
(D) P-1, Q-2, R-3, S-4

2004

128. According to international locust monitoring systems, the preferred site for desert locust oviposition is:
(A) The uppermost canopy of tall leguminous trees.
(B) Floating debris in temporary monsoon ponds.
(C) Moist, sandy soils at a depth of about 5-10 cm.
(D) Inside the hollow stems of mature cereal crops.

2009

129. The characteristic foraging damage caused by termites (e.g., Odontotermes obesus) to field crops like wheat or sugarcane is primarily mediated by their need to acquire:
(A) Acquisition of high-protein floral nectar source.
(B) Digestion of cellulose with the help of gut biota.
(C) Lipid-rich exudates from the leaf surface tissue.
(D) Specialized secondary plant metabolites for defense.

NODIA

2014

130. Based on social organization, the caste system in an Odontotermes termite colony is structurally classified into:
(A) Reproducing queens only, with no distinct worker caste.
(B) A single dominant female and exclusively male workers.
(C) Solitary adults that congregate only for foraging.
(D) Reproductives (king and queen), workers, and soldiers.

2011

131. When comparing termite damage to that of root-feeding white grubs, which feature is highly diagnostic of termites?
(A) Constructing earthen sheeting over the plants.
(B) Consuming the root without leaving soil traces.
(C) Causing the leaves to turn white immediately.
(D) Severing the stem at a perfect 90-degree angle.

2017

132. Which of the following statements CORRECTLY identifies a cultural management technique for reducing termite damage in dryland agriculture?
(A) Applying raw manure to attract them away.
(B) Using synthetic nitrogen to repulse them.
(C) Providing irrigation to reduce water stress.
(D) Cultivating soil deeply to disrupt nests.

2023

133. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): The destruction of the termite mound and extraction of the queen is a crucial step in the long-term management of mound-building termites.

Reason (R): The worker caste is completely sterile; without the queen, the colony loses its sole reproductive source and eventually collapses.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2007

134. All of the following chemical management strategies are utilized for termite control in field crops EXCEPT:

(A) Treating the seeds with insecticides before sowing.
(B) Application of granular insecticides into furrows.
(C) Drenching the soil area with insecticidal solution.
(D) Widespread aerial spraying of foliage protectants.

2004

135. The term "fungus-growing termites" applies to many species of the genus Odontotermes. What is the ecological significance of this behavior?

(A) Fungus provides a toxin that soldiers use for defense.
(B) Termites cultivate fungi to aid in predigestion.
(C) Fungus is grown to provide integrity to the mound.
(D) Fungus acts as an effective attractant for mating.

2025

136. The polyphagous nature of the Red Hairy Caterpillar (Amsacta albistriga) refers to its biological capacity to:

(A) Tolerate a wide spectrum of extreme temperatures.
(B) Complete multiple, continuous generations within a single season.
(C) Feed aggressively on a vast array of different plant species and families.
(D) Lay thousands of eggs across varied geographical locations.

2021

137. Which of the following statements about the seasonal incidence of the Red Hairy Caterpillar is INCORRECT?

(A) Its emergence is closely synchronized with the onset of the southwest monsoon showers.
(B) The adult moths are strongly attracted to light.
(C) The pupae undergo a prolonged period of aestivation/diapause in the soil during the dry season.
(D) The pest typically completes 5-6 overlapping generations per year without any diapause.

2011

138. A farmer notices large swarms of hairy caterpillars migrating rapidly across the ground from a harvested field into a newly sown adjacent field. To effectively stop this migration, the BEST mechanical intervention is to:

(A) Dig a trench dusted with insecticide.
(B) Spray water over the migrating bands.
(C) Erect a dense physical net vertically.
(D) Planting a row of tall maize as barrier.

2011

139. Match the hairy caterpillar pest in List I with its corresponding key feature in List II.

List I: (Hairy caterpillar pest)
P. Bihar hairy caterpillar
Q. Red hairy caterpillar
R. Castor hairy caterpillar
S. Sunnhemp hairy caterpillar

List II: (Key feature)
1. Amsacta moorei, typical endemic pest of dryland groundnut
2. Spilosoma obliqua, highly polyphagous, severe pest of jute and oilseeds
3. Utetheisa pulchella, specialized pest of Crotalaria
4. Euproctis lunata, possesses distinct urticating hairs causing skin irritation

(A) P-2, Q-1, R-4, S-3
(B) P-3, Q-1, R-4, S-2
(C) P-2, Q-1, R-4, S-3
(D) P-4, Q-3, R-2, S-1

2013

140. The early instars of both the Red and Bihar hairy caterpillars exhibit which characteristic feeding behavior?

(A) Boring individually into the main stems.
(B) Feeding gregariously, skeletonizing leaves.
(C) Mining deeply into the mesophyll layer.
(D) Actively preying on smaller insect pests.

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10. (A) Bracts of the fruiting body opening prematurely due to internal larval feeding.
Flared squares in cotton are a diagnostic symptom caused by the internal feeding of bollworm larvae. When the larvae bore into the squares or young floral buds, the injury triggers a physiological response that causes the bracts to open prematurely and turn yellow. These damaged squares eventually wither and drop from the plant, resulting in significant yield loss.

11. (B) Stem borer (Chilo partellus) larvae eject fecal pellets through boreholes on the stalk.
The spotted stem borer is a major pest of maize that tunnels into the stalks during the vegetative and reproductive stages. As the larvae feed internally, they must remove metabolic waste and digested plant tissue from their galleries. This results in the characteristic extrusion of sawdust-like fecal pellets, or frass, through small boreholes visible on the outer stem.

12. (B) Drying and death of the central shoot while older leaves remain green.
The dead heart symptom is a common indicator of stem borer or shoot fly infestation in many cereal crops. It occurs when the larva feeds on the growing point or severs the central vascular tissue. This causes the youngest, central leaf to dry and die, while the outer, older leaves remain green for a period before the plant collapses.

13. (A) P-2, Q-1, R-4, S-3
Different rice and cotton pests produce unique diagnostic symptoms in the field. The gall midge causes silver shoots, while the pink bollworm leads to flared squares in cotton. Sorghum shoot fly damage is identified by dead hearts in seedlings, and the brown planthopper is associated with hopper burn. Correct symptom identification is essential for implementing effective pest management strategies.

14. (C) They physically eliminate the entire pest population from the field.
Pheromone traps are excellent tools for pest surveillance because they are species-specific and can detect the initial arrival of adult moth flights. They operate continuously and help in timing management interventions accurately. However, they are designed primarily for monitoring and mass trapping rather than the complete physical elimination of an entire pest population from a large agricultural field.

15. (D) Percentage of tillers showing dead hearts or white ears per unit area.
To determine the intensity of stem borer damage in rice, researchers and farmers measure the percentage of affected tillers. During the vegetative stage, this is recorded as the proportion of dead hearts, whereas white ears are counted during the reproductive stage. These indices provide a direct measure of the economic impact and help in making management decisions.

16. (C) The systematic monitoring and recording of pest population dynamics and damage.
Scouting is a fundamental component of integrated pest management that involves the regular and systematic inspection of a field. During this process, observers record the population levels of pests, the presence of natural enemies, and the extent of crop damage. This data is essential for determining if pest densities have reached the economic threshold required for initiating treatment.

17. (B) Sequential sampling requires a fixed, predetermined number of samples regardless of pest density.
Sequential sampling is an efficient method where the total number of samples is not fixed in advance. Instead, the sampling process continues only until enough data is collected to make a management decision based on established thresholds. This approach often requires fewer samples when pest populations are either very high or very low, saving time and labor for the scout.

18. (D) Conduct night-time scouting to detect nocturnal pests like cutworms.
Many significant agricultural pests, such as cutworms and certain armyworms, exhibit nocturnal behavior and remain hidden in the soil or under debris during the day. If significant defoliation is observed but no pests are found during daylight hours, it is essential to conduct scouting at night. This allows for the direct observation and identification of these hidden pests.

NODIA

19. (A) I and II
Several common assumptions about pest surveillance tools are incorrect. Light traps are primarily effective for capturing nocturnal insects and are not suitable for diurnal species. Similarly, sweep net sampling is used for insects

2021

150. What environmental trigger is typically responsible for the synchronized mass emergence of adult white grubs (chafer beetles) from the soil?
(A) The onset of freezing winter temperatures.
(B) A severe, prolonged drought exceeding months.
(C) The specific day-length reaching solstice.
(D) Occurrence of major pre-monsoon showers.

2002

151. An area-wide management campaign for white grubs often targets the adult stage. Why is this strategy highly effective?
(A) The adults are flightless and can be easily crushed.
(B) Adults congregate on host trees for mating at night.
(C) The adults die after taking flight, limiting numbers.
(D) The adults are the only stage feeding on field crops.

2017

152. Taxonomically, the white grub (Holotrichia spp.) belongs to the insect order Coleoptera, specifically within the family:
(A) Curculionidae
(B) Chrysomelidae
(C) Scarabaeidae
(D) Cerambycidae

2019

153. When comparing the management of white grubs to that of shoot borers, which approach is unique and essential for white grub control?
(A) Routine use of foliar pyrethroid sprays during flowering.
(B) Deployment of sticky yellow traps in the center of fields.
(C) Clipping of the seedling tips before transplanting crops.
(D) Use of soil application of fungi or granular chemicals.

2017

154. Which of the following CORRECTLY describes a key morphological feature of the white grub larva?
(A) A brown head, thoracic legs, and "C"-shaped body.
(B) It is entirely legless with a highly reduced head capsule.
(C) It features multiple prolegs extending along the entire length of its abdomen.
(D) It is covered densely in long, urticating defensive hairs.

2008

155. All of the following are foundational principles of an Integrated Pest Management (IPM) program for field crops EXCEPT:
(A) Regular scouting and utilization of economic threshold levels.
(B) The prophylactic, scheduled application of broad-spectrum chemical insecticides.
(C) Conservation and augmentation of natural enemy populations.
(D) Integration of cultural, physical, biological, and carefully targeted chemical methods.

2021

156. In an IPM program for cotton, the use of okra (Bhindi) planted around the field borders serves primarily as:
(A) A trap crop to attract spotted bollworms.
(B) A dense physical barrier against winds.
(C) Source of secondary income for the farm.
(D) A repellent crop that deters whiteflies.

2024

157. The egg parasitoid Trichogramma chilonis is widely utilized in field crop IPM. Which specific pest stage does it directly destroy?
(A) It parasitizes and prevents the hatching of lepidopteran eggs.
(B) It paralyzes and consumes the early instar larvae.
(C) It infects the pupae residing in the soil.
(D) It sterilizes the adult females upon contact.

2002

158. Identify the INCORRECT statement regarding biological control agents used in field crop IPM.
(A) Chrysoperla carnea (green lacewing) larvae are aggressive generalist predators of aphids and soft-bodied insects.
(B) Entomopathogenic nematodes (EPNs) are effective for targeting subterranean pests like white grubs.
(C) Bacillus thuringiensis (Bt) is primarily effective against the adult stage of sap-sucking insects.
(D) NPV (Nucleopolyhedrovirus) is a highly host-specific viral pathogen used for controlling specific caterpillars like Spodoptera or Helicoverpa.

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2018

141. The characteristic defense mechanism of hairy caterpillars against many generalist avian predators is primarily due to:
(A) Dense covering of long and irritating hairs.
(B) Their ability to fly rapidly when disturbed.
(C) Their deep subterranean burrowing behaviors.
(D) Secretion of foul-smelling liquid from body.

2023

142. Cutworms (Agrotis spp.) are classified functionally within agricultural entomology primarily as:
(A) Diurnal, arboreal defoliators
(B) Crepuscular, floral part borers
(C) Nocturnal, soil-dwelling seedling pests
(D) Strictly subterranean root miners

2021

143. When comparing the feeding damage of cutworms to that of armyworms, which of the following represents the most distinct difference?
(A) Cutworms feed on grains, while armyworms feed on roots.
(B) Cutworms secrete webbing, while armyworms do not spin.
(C) Cutworms feed only by day, while armyworms are active.
(D) Cutworms sever plants, while armyworms strip foliage.

2009

144. Which of the following correctly describes a recommended management practice for mitigating cutworm damage in potato or gram fields?
(A) Flooding the field for a month prior to sowing the crop.
(B) Application of foliar systemic insecticides at midday.
(C) Broadcasting poison bait during the late evening hours.
(D) Intercropping with highly susceptible host plant types.

2021

145. All of the following biological traits are characteristic of Agrotis ipsilon (Black cutworm) EXCEPT:
(A) The larvae possess a distinct habit of curling into a 'C' shape when disturbed.
(B) The eggs are laid exclusively deep within the vascular bundles of the host plant.
(C) The pest exhibits a migratory behavior in certain regions, moving to higher altitudes during summer.
(D) The larvae remain hidden in soil cracks or under debris during daylight hours.

2021

146. A crop of newly emerged chickpea seedlings is found completely toppled over in the morning, with a clean cut at the collar region. Digging the soil around the cut stems reveals greasy, dark-grey caterpillars. What is the most likely identity of the pest?
(A) Gram pod borer (Helicoverpa armigera)
(B) White grub (Holotrichia consanguinea)
(C) Wireworm (Agriotes spp.)
(D) Greasy cutworm (Agrotis ipsilon)

NODIA

2015

147. The overwintering biology of many cutworm species in temperate and subtropical climates is primarily characterized by survival as:
(A) Pupae enclosed in earthen cells within the soil matrix.
(B) Active adults hidden within the plant crop canopy.
(C) Eggs laid securely on the upper leaf surface parts.
(D) First-instar larvae aestivating inside dried stems.

2017

148. Identify the INCORRECT statement regarding the cultural control of cutworms.
(A) Early ploughing of fields helps expose hiding caterpillars to predatory birds.
(B) Keeping fields clear of dense weed cover prior to planting reduces oviposition sites.
(C) Delayed harvesting of the previous crop forces the pest to starve.
(D) Use of well-decomposed manure is preferred, as raw manure may harbor and attract cutworms.

2001

149. The severe economic damage caused by white grubs (e.g., Holotrichia consanguinea) to groundnut and sugarcane is mechanistically due to:
(A) Feeding on the root system by "C"-shaped larvae.
(B) Transmission of viral diseases by adult beetles.
(C) Adult beetles boring into the stalks of the plant.
(D) Larvae extracting sap from the host root nodules.

ANSWERS

1. (B) Economic Injury Level
The economic injury level represents the critical point where the cost of managing a pest population is exactly balanced by the value of the crop yield saved. It serves as a fundamental metric in integrated pest management, defining the lowest density of pests capable of causing economic damage to the agricultural produce during a specific growing season.

2. (D) Natural enemy population density
Calculating the economic injury level requires specific economic and biological data including management costs, crop market value, and the efficacy of control interventions. While natural enemies influence pest population dynamics, their specific density is not a primary mathematical component in the standard formula used to determine the threshold for initiating chemical control measures in field crops.

3. (A) Non-economic pest
If the general equilibrium position of a pest species is consistently maintained well below the damage boundary, the population never reaches levels that cause economic loss. Such species are categorized as non-economic pests because their presence does not justify the cost of management interventions. They remain part of the ecosystem without impacting the profitability of the agricultural system.

4. (C) Damage Boundary
The damage boundary is the lowest level of injury that results in a measurable reduction in crop yield. This point is determined strictly by the biological relationship between the pest and the host plant, independent of economic factors like crop price or treatment costs. It marks the transition from harmless feeding to actual physiological impact on the harvested produce.

5. (A) It represents the density where damage exceeds the crop's physiological tolerance.
The economic threshold level is defined as the pest density at which management measures must be initiated to prevent the population from reaching the economic injury level. It is essentially an action threshold that provides a safety buffer. It does not represent the point where damage exceeds physiological tolerance, as that biological milestone is specifically associated with the damage boundary.

NODIA

6. (D) When the pest population reaches the Economic Threshold Level and is increasing.
The application of chemical treatments is economically justified only when the pest population reaches the economic threshold level and shows a rising trend. At this specific point, intervention is necessary to prevent the population from escalating to the economic injury level. Applying treatments based on these criteria ensures cost-effectiveness while minimizing unnecessary environmental exposure to synthetic pesticides.

7. (C) A is false but R is true.
The yellow stem borer causes two distinct types of damage depending on the growth stage of the rice plant. During the vegetative phase, larval feeding results in dead hearts, while infestation during the reproductive stage leads to white ears. The larva severs the plant base, preventing nutrient flow to the developing panicle, which results in empty and chaffy grains.

8. (C) Continuous drainage of plant sap by planthoppers leading to rapid desiccation.
Hopper burn is a severe physiological disorder in rice caused by the feeding of large populations of planthoppers. These insects utilize their piercing-sucking mouthparts to extract enormous quantities of sap from the vascular tissues of the plant. This continuous drainage of nutrients and water leads to rapid desiccation, causing the rice plants to turn brown and dry.

9. (D) Asian rice gall midge (Orseolia oryzae)
Infestation by the Asian rice gall midge is uniquely characterized by the formation of silver shoots or onion leaf symptoms. The larva feeds at the growing point of the tiller, secreting chemicals that stimulate the leaf sheath to grow into a hollow, tubular structure. This abnormal growth prevents panicle development and leads to significant loss in total grain yield.

2007

109. Consider the following statements regarding sugarcane borers:

I. The top borer pupates within the cane after constructing a silken gallery and an exit hole.

II. The early shoot borer is generally more severe in waterlogged, poorly drained soils.

III. The internode borer attack is characterized by fresh frass in the nodal region.

IV. The root borer primarily enters the cane through the buds on the setts.

Which of the above statements are INCORRECT?

(A) II and IV
(B) I and III
(C) I, II and IV
(D) II, III and IV

2013

110. All of the following statements about the sugarcane leafhopper (Pyrilla perpusilla) are correct EXCEPT:

(A) The nymphs possess two characteristic long anal filaments.
(B) It causes damage by extracting sap and excreting copious amounts of honeydew.
(C) It strictly requires alternate aquatic weed hosts to complete its pupal stage.
(D) Severe infestations lead to a decline in the sucrose content of the cane.

2003

111. The most successful, sustainable, and widely adopted biological control strategy for the management of Pyrilla in sugarcane involves the conservation and redistribution of:

(A) The egg parasitoid Trichogramma chilonis
(B) The predatory ladybird beetle Coccinella septempunctata
(C) The entomopathogenic nematode Steinernema carpocapsae
(D) The epipyropid ectopaitoid Epiricania melanoleuca

2015

112. Sugarcane scale insects (Melanaspis glomerata) predominantly encrust and cause damage to which specific part of the plant?

(A) Internal vascular bundles of the upper internodes.
(B) Upper surface of the newly emerged whorl leaves.
(C) Nodal regions concentrated under the leaf sheaths.
(D) Root system lying deep below the soil surface.

2014

113. Which of the following statements regarding the sugarcane whitefly (Aleurolobus barodensis) is INCORRECT?

(A) The adult flies possess wings covered with a fine waxy powder.
(B) The nymphs are highly mobile and actively bore into the cane stalks.
(C) Infestations are typically localized in waterlogged or nitrogen-deficient areas of the field.
(D) It causes yellowing and drying of leaves, severely affecting photosynthesis.

2011

114. The widespread presence of sooty mold on sugarcane foliage, giving the field a blackened appearance, is an indirect consequence of an outbreak of:

(A) Top borer
(B) Root borer
(C) Termites
(D) Pyrilla

2025

115. Consider the following statements concerning the management of sap-sucking pests in sugarcane:

I. Burning of trash is highly recommended to conserve Epiricania melanoleuca cocoons.

II. Avoiding ratoon crops in scale-insect-endemic areas helps break the pest cycle.

III. Good drainage and balanced fertilization reduce the severity of whitefly infestations.

IV. Sett treatment with appropriate systemic insecticides helps manage early scale insect establishment.

V. Pyrilla outbreaks are generally suppressed by prolonged, heavy monsoon rains.

Which of the above statements are correct?

(A) II, III, IV and V
(B) I, IV and V
(C) II, III, IV and V
(D) I, III, IV and V

2001

116. Epiricania melanoleuca, the crucial parasitoid of Pyrilla perpusilla, belongs to the insect order:

(A) Hymenoptera
(B) Diptera
(C) Lepidoptera
(D) Neuroptera

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inhabiting the plant canopy and is entirely unreliable for estimating populations of soil-dwelling larvae. Pitfall traps remain a standard tool for monitoring ground-dwelling arthropods in fields.

20. (C) The pest's polyphagous nature allowing it to transition from wheat to rice.
The pink stem borer has become a significant pest in rice-wheat cropping systems due to its polyphagous feeding habits. This allows the insect to maintain continuous populations by transitioning between the two major cereal crops throughout the year. The lack of a fallow period and the availability of host plants in both seasons facilitate the rapid buildup of this pest.

21. (A) The male has distinct dark spots on the forewings, which the female lacks.
Adult yellow stem borers exhibit clear sexual dimorphism. The male moth is generally smaller and possesses a series of distinct dark spots on the forewings. In contrast, the female moth is larger and is characterized by a single prominent black spot on each forewing, along with a distinct tuft of brownish-yellow anal hairs used for covering the egg masses.

22. (D) Crambidae
Taxonomically, the striped rice borer is classified within the family Crambidae in the order Lepidoptera. This family includes many significant agricultural pests known for their stem-boring habits in various cereal crops. Understanding the specific family classification is important for entomological studies, as it relates to the physiological and behavioral traits shared among many closely related lepidopteran borer species.

23. (B) Ability to undergo larval diapause in rice stubbles during the dry season.
The white stem borer is closely related to the yellow stem borer but possesses distinct biological adaptations. In regions with clear wet and dry seasons, this species undergoes a mandatory larval diapause within the rice stubbles to survive the unfavorable dry period. This behavior allows the pest population to persist until the next cropping cycle begins with the onset of monsoon.

24. (C) Clipping the seedling tips before transplanting reduces the carryover of borer eggs.
Clipping the tips of rice seedlings before transplanting is an effective cultural practice for managing stem borers. Female moths often prefer to lay their egg masses near the tips of the leaves in the nursery. By removing these tips, farmers significantly reduce the number of eggs carried into the main field, thereby lowering the initial population of the borer larvae.

25. (A) I and III
The bionomics of rice stem borers vary across species. The yellow stem borer is a monophagous pest that depends strictly on rice for its development. The white stem borer is strongly influenced by seasonal cycles, with outbreaks often tied to the transition between dry and wet periods. Most stem borer larvae pupate within the stem rather than in the soil.

26. (A) Indiscriminate early-season application of broad-spectrum insecticides.
Managing brown planthopper outbreaks requires avoiding the indiscriminate use of broad-spectrum insecticides, especially early in the season. Such applications often destroy natural enemies, leading to pest resurgence. Recommended practices include providing alleyways for aeration, using resistant varieties, and practicing alternate wetting and drying of the field to create a less favorable microclimate for the insects at the plant base.

NODIA

27. (B) Both adults and nymphs extract milky sap from developing grains.
The Gundhi bug is most destructive during the milky stage of rice grain development. Both the nymphs and adults use their piercing-sucking mouthparts to extract the sap from the immature, soft grains. This feeding activity results in empty or partially filled grains, often characterized by a brown or black spot at the site of the puncture, reducing yield.

28. (B) Depletion of plant sap and damage to vascular tissues by planthoppers.
Hopperburn is a characteristic symptom of severe planthopper infestation in rice fields. It results from the collective feeding of large numbers of insects at the base of the plants. The continuous extraction of sap and the resulting damage to the vascular tissues prevent the movement of

67. (A) I and III
The painted bug causes damage by sucking sap from the leaves and pods of rapeseed and mustard. The mustard sawfly, which belongs to the order Hymenoptera, has larvae that exhibit a characteristic habit of curling up and dropping to the ground when they are disturbed. These biological traits are important for identifying and managing these pests during the cropping season.

68. (C) Three thoracic and six to eight pairs of prolegs.
The larva of the mustard sawfly is a caterpillar-like insect that can be distinguished from lepidopteran larvae by the number of prolegs. Sawfly larvae possess three pairs of true thoracic legs and typically six to eight pairs of abdominal prolegs. This morphological feature is diagnostic for the group and is useful for correct pest identification in the field.

69. (A) Escaping peak incidence of the mustard aphid.
Early sowing of rapeseed and mustard is a highly effective cultural strategy for managing the mustard aphid. By planting the crop before mid-October, the plants are able to pass through their most susceptible growth stages before the aphid population reaches its peak in the cooler, more humid months of winter. This helps in achieving better yields with fewer insecticide applications.

70. (D) Mustard sawfly
Among the common pests of mustard, the painted bug and the mustard aphid are both members of the order Hemiptera, characterized by their piercing-sucking mouthparts. The mustard sawfly, however, belongs to the order Hymenoptera. Its larvae have chewing mouthparts and feed on the leaf tissue, causing extensive defoliation that is different from the sap-sucking damage caused by hemipteran pests.

71. (B) Sawfly larva chews leaves while the bug sucks plant sap.
The mustard sawfly and the painted bug differ fundamentally in their feeding mechanisms. The sawfly larva possesses chewing mouthparts and consumes the leaf tissue, often leaving only the midribs in severe cases. In contrast, the painted bug is a hemipteran that uses its piercing-sucking mouthparts to extract sap from the plant cells, leading to wilting and the formation of white spots.

72. (C) Larvae mine the leaflets producing blisters.
The groundnut leaf miner is a significant pest that causes characteristic damage during its larval stage. The young larvae bore into the leaflets and feed between the upper and lower epidermal layers. This internal feeding creates white or brownish mines that eventually appear as blisters on the leaf surface. In severe infestations, the leaves turn brown, wither, and eventually drop from the plant.

73. (B) III only
Groundnut is affected by several major pests, including the tobacco caterpillar, thrips, and white grubs. Jassids cause characteristic V-shaped yellowing at the leaf tips, and white grubs destroy the roots. However, the statement regarding the groundnut leaf miner is incorrect, as this pest typically thrives and causes more severe damage during dry spells rather than periods of heavy, continuous rainfall.

74. (A) The larvae strictly confine their feeding to the root nodules underground.
The tobacco caterpillar is an aggressive defoliator of groundnut and other crops. The early instar larvae feed gregariously on the leaves, skeletonizing them, while the older larvae disperse and consume the entire leaf. The adult female lays prominent egg masses covered with brownish scales. These insects feed on the foliage and do not target the root nodules underground.

75. (B) Using sticky traps and systemic sprays.
Necrotic terminal buds and stunted growth in groundnut, combined with the presence of tiny fringed-wing insects in the flowers, indicate a severe thrips infestation. Thrips are also vectors for the groundnut bud necrosis virus. An effective management strategy includes the use of blue or yellow sticky traps for monitoring and the application of systemic insecticides to control the pest population.

76. (B) Empoasca kerri (Jassids)
Hopperburn in groundnut is primarily caused by the feeding of jassids. These insects inject toxic saliva into the plant while sucking sap from the leaf veins. This results in the characteristic V-shaped yellowing at the leaf tips, which eventually turns brown and spreads across the

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38. (D) Flooding the field during the seedling stage to suffocate the larvae.
Management of the wheat armyworm involves several integrated strategies such as late-evening insecticide applications and summer ploughing to expose pupae. Poison baits are also used effectively around field margins to intercept migrating larvae. However, flooding the field during the seedling stage is not a standard or effective practice for controlling this specific pest, which primarily feeds on the upper plant parts.

39. (B) The larvae conceal themselves deep within the protective plant whorl.
The Fall Armyworm is particularly difficult to manage in maize because the larvae exhibit a cryptic feeding habit. They quickly migrate into the central whorl of the plant, where they are protected from contact insecticides and many natural enemies. This concealment requires specific application techniques, such as directed sprays into the whorl, to ensure the pesticide reaches the target pest.

40. (C) The drying of the central leaf due to larval feeding at the point.
In sorghum, the shoot fly larva bores into the central shoot of young seedlings. By feeding on the growing point, the larva causes the youngest leaf to wither and dry up, forming a characteristic dead heart. This symptom is a primary indicator of shoot fly infestation and typically occurs within the first few weeks after the crop emerges from the soil.

41. (D) It undergoes diapause as a pupa within the soil during the winter season.
The spotted stem borer is a major pest of maize and sorghum, characterized by the production of shot-holes on leaves during the vegetative stage. While it does undergo diapause to survive the winter, it typically does so as a mature larva within the stubbles or stalks of the host plant, rather than as a pupa in the soil matrix.

42. (A) Sorghum shoot fly; advance the sowing date to early monsoon.
High levels of dead hearts in late-sown sorghum seedlings are a classic sign of shoot fly infestation. The pest population increases significantly as the season progresses, making late-sown crops highly vulnerable. Advancing the sowing date to the early monsoon ensures that the seedlings pass through their most susceptible stage before the peak population of the shoot fly develops.

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43. (A) II, IV, I, III
The Fall Armyworm exhibits a specific progression of damage as the maize plant develops. Initial symptoms include window-pane damage on young leaves caused by early instars. As the larvae mature, they produce elongated papery patches before moving deep into the whorl to cause complete destruction. Finally, they target the reproductive structures, feeding directly on the developing ears and kernels.

44. (B) Singly on the lower leaf surface, usually parallel to the leaf midrib.
Female sorghum shoot flies lay their eggs singly on the underside of the leaves of young seedlings. The eggs are white and elongated, typically positioned parallel to the midrib. After hatching, the larvae crawl down the leaf and enter the space between the leaf sheath and the stem to reach the growing point, where they begin their destructive feeding.

45. (A) It must migrate and rely on overlapping hosts for continuous generations.
The Fall Armyworm lacks a true diapause mechanism, which means it cannot survive long periods of cold or host absence in a dormant state. Consequently, the pest must continuously migrate to areas where host plants are available and temperatures are favorable. This biological trait drives its status as a persistent, year-round threat in tropical and subtropical agricultural regions.

46. (C) Polyphagous pest of reproductive plant structures.
The gram pod borer is a highly polyphagous insect that attacks a wide variety of crops across different families. It shows a strong preference for the reproductive structures of its hosts, such as flowers, squares, and pods. This feeding habit makes it exceptionally destructive, as it directly impacts the parts of the plant that contribute most significantly to the final harvest.

47. (D) On cotton, it causes flared squares, while on chickpea, it bores into the pods.
Helicoverpa armigera exhibits different damage symptoms depending on the host crop. On cotton, larval feeding on the floral buds leads to the characteristic flared squares and premature

86. (D) The larvae construct prominent protective silken webs across the leaf canopy.
The spotted bollworm causes significant damage to cotton by boring into terminal shoots early in the season and later into squares and bolls. Damaged bolls often show boreholes that are blocked with excreta. Unlike the leaf roller, the spotted bollworm does not construct silken webs across the leaf canopy, as its feeding is primarily focused on the internal tissues of shoots and reproductive organs.

87. (B) The bollworm complex of American and pink species.
The introduction and widespread adoption of transgenic Bt cotton in India were primarily aimed at managing the destructive bollworm complex. This complex includes the American bollworm, the pink bollworm, and the spotted bollworm. The Bt toxin expressed in the plant tissues is highly effective against these lepidopteran larvae, providing internal protection that significantly reduced the need for multiple foliar insecticide applications.

88. (C) To produce susceptible pests for mating.
The fundamental purpose of planting refuge crops alongside transgenic Bt cotton is to manage the development of insect resistance. These non-Bt plants provide a habitat where susceptible pests can survive and reproduce. The resulting susceptible adults then mate with any rare resistant individuals emerging from the Bt crop, ensuring that resistance genes remain diluted within the overall population.

89. (C) Spotted bollworm requires an adult diapause in the summer.
The different species in the cotton bollworm complex have various survival strategies. The American bollworm undergoes pupal diapause in the soil, while the pink bollworm undergoes a mandatory larval diapause within the seeds. However, the spotted bollworm does not typically undergo a mandatory adult diapause in the summer; instead, it often maintains populations on alternate host plants throughout the year.

90. (A) Helicoverpa armigera (American bollworm)
The American bollworm exhibits a very characteristic feeding behavior on cotton bolls. The larva typically bores into the boll with its anterior half inside to feed on the contents, while its posterior half remains outside. This posture, combined with its striped and sparsely hairy morphology, is a definitive diagnostic feature used by farmers and scouts to identify this specific pest in the field.

91. (C) Both A and R are true and R is the correct explanation of A.
The cotton whitefly is a significant threat because it functions as the exclusive vector for the Cotton Leaf Curl Virus. While direct sap extraction weakens the plant, the transmission of this viral pathogen causes irreversible damage, including severe stunting and leaf deformations. Managing whitefly populations is therefore essential for preventing the widespread epidemic of viral diseases in cotton-growing regions.

92. (B) Mealybugs and whiteflies
Sticky cotton is a serious problem for the textile industry, caused by the contamination of lint with honeydew. This sticky substance is excreted by sap-sucking insects like mealybugs and whiteflies during heavy infestations. The honeydew promotes the growth of sooty mold and makes the cotton fiber difficult to process during ginning and spinning, significantly reducing the market value of the lint.

93. (A) Repeated application of sprays that kill natural enemies.
The sudden resurgence of pests like the cotton mealybug is often an unintended consequence of excessive chemical use. When broad-spectrum insecticides are applied repeatedly to control other pests, they often kill the diverse group of natural enemies, such as ladybird beetles and parasitic wasps, that normally keep mealybug populations in check. This lack of natural regulation allows the mealybug population to explode.

94. (C) Jassids feeding on sap.
Jassids cause characteristic symptoms on cotton leaves due to their sap-sucking habits and the injection of toxic saliva. The early signs of an attack include the downward curling and crinkling of the leaf margins. This is often followed by the yellowing and eventual browning of the leaf edges, a condition known as hopperburn, which severely impacts the plant's photosynthetic capacity.

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57. (D) Larval and pupal development occurs concealed within the pod.
The Tur pod fly is difficult to manage because its entire developmental cycle, from egg to pupa, takes place inside the pigeonpea pod. The female fly inserts her eggs directly into the pod tissue, and the larvae feed on the seeds without being exposed to the environment. This concealment protects the pest from most contact insecticides applied to the crop surface.

58. (A) Clavigralla gibbosa
Among the common pests of pigeonpea, the pod bug belongs to a different functional classification compared to the others. While the Tur pod fly, spotted pod borer, and plume moth are chewing insects that consume plant tissues, the pod bug is a sap-sucking insect. It uses specialized piercing-sucking mouthparts to extract nutrients, resulting in shriveled grains rather than direct consumption of tissue.

59. (B) Small, circular shot-holes on the foliage of young seedlings.
The galerucid beetle is a significant early-season pest of moong bean. The adults feed on the leaves of young seedlings, creating numerous small, circular holes known as shot-holes. This damage differs from the internal tunneling caused by the stem fly. While extensive leaf damage can weaken the seedlings, it is the visible holes that are the primary diagnostic sign of this beetle.

60. (B) Principal vector for the Yellow Mosaic Virus (MYMV).
In the cultivation of moong and urd beans, the whitefly serves as the critical vector for the Yellow Mosaic Virus. While the nymphs and adults cause some direct damage through sap extraction, the transmission of this viral pathogen leads to characteristic yellow mottling and severe yield reduction. Management must therefore focus on reducing the vector population to control the spread of the disease.

61. (A) I and II
Thrips are known vectors for the groundnut bud necrosis virus in cowpea, and the stem fly causes significant damage by tunneling into the stem tissue of young seedlings. These two pests represent major threats during the early growth stages of legumes. However, the galerucid beetle is a chewing pest that creates holes in leaves rather than a phloem feeder causing hopperburn.

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62. (C) Frequent irrigation to drown the whiteflies.
Cultural management of whiteflies in moong bean includes synchronized sowing, effective weed management to remove alternate hosts, and the use of resistant varieties. These practices aim to reduce the initial population and slow the spread of viral diseases. Frequent irrigation is not used as a method to drown whiteflies, as these insects are highly mobile and reside on the leaf undersides.

63. (D) Split the stem to observe internal red tunnels.
The most reliable way to confirm a stem fly infestation in legumes is to examine the internal tissue of the plant. By splitting the stem of a wilting or stunted seedling, one can observe the characteristic red or brownish tunnels created by the burrowing larvae. These tunnels disrupt the flow of water and nutrients, which eventually leads to the death of the seedling.

64. (C) Deformed flowers that drop prematurely.
Thrips infestation in moong bean primarily affects the reproductive parts of the plant. These tiny insects feed on the tender floral tissues, causing the flowers to become distorted or deformed. This injury often results in the premature dropping of the flowers, which significantly reduces the number of pods produced and can lead to a total crop failure if the population is high.

65. (B) The pest exclusively reproduces sexually throughout its life cycle in Indian plains.
The mustard aphid is a major pest that thrives in humid, cloudy weather, causing leaves to curl and dry out. In the Indian plains, this pest predominantly reproduces asexually through parthenogenesis during the crop season, allowing for extremely rapid population increases. The secretion of honeydew by these large colonies further damages the plant by encouraging the growth of black sooty mold.

66. (D) Painted bug
The painted bug is a significant pest of mustard seedlings and ripening pods. Both adults and nymphs are easily recognized by their dark bodies with bright orange or red and black markings. They suck sap from the host plant, causing the seedlings to wilt and dry up. These insects are often found congregating in large numbers on the stems and leaves during the early morning.

into the young shoots, causing the death of the central leaf and the formation of dead hearts. This early damage can significantly reduce the number of millable canes per hectare, making the pre-monsoon period the most critical time for monitoring and management.

105. (D) A dead heart with a bunchy top plant appearance.
The top borer is a major pest of sugarcane that attacks the apical growing point. Larval feeding in this region results in a characteristic dead heart. To compensate for the loss of the primary growing point, the plant's lateral buds often sprout prematurely, leading to a "bunchy top" appearance. This symptom is highly diagnostic for identifying top borer infestations in mature sugarcane.

106. (A) Internode borer damaging the quality of the setts.
The internode borer primarily attacks the sugarcane after the internodes have started to form. While it may not kill the entire plant, its tunneling activity inside the internodes reduces the juice quality and the overall weight of the cane. Importantly, it can also damage the buds on the setts, making them unsuitable for use as propagation material in the next planting season.

107. (B) ESB dead heart pulls easily while root borer does not.
In sugarcane, the dead hearts caused by the early shoot borer and the root borer can be distinguished by a simple physical test. A dead heart caused by the early shoot borer typically pulls out easily from the plant and often emits a foul odor due to decay. In contrast, the dead heart caused by the root borer is firmly attached and cannot be easily pulled out.

108. (A) Detrashing of the dry lower leaves regularly.
Detrashing, which involves the removal of the dry lower leaves of the sugarcane plant, is a recommended cultural practice for managing several pests, including the internode borer. By removing these leaves, farmers eliminate the hiding places for the moths and the sites for egg-laying. This practice also improves aeration and reduces the humidity within the crop canopy, making it less favorable for the pest.

109. (A) II and IV
The early shoot borer is typically more severe under hot and dry conditions, rather than in waterlogged soils. Additionally, the root borer larvae usually enter the plant through the base of the shoot or the roots, not through the buds on the setts. These distinctions are critical for accurately identifying the environmental factors that promote specific borer outbreaks in different sugarcane growing regions.

110. (C) It strictly requires alternate aquatic weed hosts to complete its pupal stage.
The sugarcane leafhopper, Pyrilla, is a major sap-sucking pest characterized by nymphs with two long anal filaments. It causes damage by extracting sap and producing honeydew, which leads to sooty mold growth and reduced sugar content. This insect does not require aquatic weed hosts; instead, it completes its entire life cycle on sugarcane and other graminaceous plants in the surrounding area.

111. (D) The epipyropid ectoparasitoid Epiricania melanoleuca
The management of the sugarcane leafhopper, Pyrilla perpusilla, relies heavily on the biological control provided by the ectoparasitoid Epiricania melanoleuca. This lepidopteran parasitoid is highly effective in field conditions, as its larvae feed on the nymphs and adults of the pest. Conservation and redistribution of its cocoons and egg masses are standard practices in sustainable and sustainable sugarcane production systems.

112. (C) Nodal regions concentrated under the leaf sheaths.
Sugarcane scale insects are small, sedentary pests that predominantly encrust the nodal regions of the cane. They are typically found concentrated under the protection of the leaf sheaths, where they suck sap from the stem. These infestations can lead to shriveled canes, reduced juice quality, and poor germination of setts, making them a significant threat in endemic areas where ratoon cropping is common.

113. (B) The nymphs are highly mobile and actively bore into the cane stalks.
The sugarcane whitefly is a sap-sucking insect whose adults have wings covered in waxy powder. It is often found in waterlogged or nitrogen-deficient fields, causing yellowing and drying of leaves. However, the nymphs are not highly

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leaf. Severe hopperburn can lead to significant reductions in photosynthesis and the overall yield of the crop.

77. (A) Application of broad-spectrum contact insecticides is most effective when the larvae are fully enclosed within the leaf mines.
Managing the groundnut leaf miner involves monitoring with light traps, avoiding water stress, and conserving natural enemies like parasitoids. Broad-spectrum contact insecticides are generally less effective once the larvae are hidden within their mines, as the leaf tissue protects them from direct contact. Systemic insecticides or applications targeting the early, exposed stages are more appropriate for effective control of this pest.

78. (C) Capitulum borer feeding on the floral face.
The capitulum borer is a major pest of sunflower that specifically targets the reproductive head of the plant. The larvae feed on the developing seeds and the floral tissues, often creating a mess of frass and silk webbing over the face of the sunflower. This direct damage to the seeds significantly reduces the oil yield and the quality of the harvested crop.

79. (B) Egg → Larval webbing/feeding → Pupation within webbed leaves → Adult emergence
The Til leaf webber and gall fly completes its life cycle in a specific sequence on the sesame plant. The eggs are laid on the leaves, and the larvae web together the leaves and flowers to feed in a protected environment. Unlike many other pests that pupate in the soil, this species typically pupates within the webbed leaves or pods before emerging as an adult.

80. (C) Draining sap from leaves and stems causing poor growth.
The safflower aphid is the most significant pest of safflower, capable of causing severe economic losses. These small insects congregate in massive numbers on the stems and leaves, extracting large quantities of plant sap. This continuous feeding results in stunted growth, yellowing of the foliage, and a significant reduction in the number and size of the floral heads and seeds.

81. (B) Suppression of the population due to washing away of adults.
Heavy and unseasonal rainfall can have a significant impact on the population dynamics of the sesame gall fly. The physical action of the rain can wash away the small, delicate adult flies and disrupt their mating and egg-laying activities. This environmental factor often leads to a natural suppression of the pest population, reducing the severity of the infestation in the subsequent growth stages.

82. (B) Borer attacks the floral head, while webber attacks foliage.
The capitulum borer and the Til leaf webber differ primarily in the specific parts of the plant they target. The capitulum borer focuses its feeding on the floral head and developing seeds of crops like sunflower. In contrast, the Til leaf webber primarily binds and consumes the foliage and flowers of sesame, although it can also damage the developing pods in severe cases.

83. (A) Provides a physical barrier that intercepts migrant aphids.
Using boundary cropping with a tall cereal like sorghum is an effective strategy for managing safflower aphids. The tall plants serve as a physical barrier that intercepts the winged aphids as they migrate into the field. This reduces the number of aphids that reach the main safflower crop, slowing down the establishment and spread of the infestation throughout the agricultural area.

84. (C) Flowers failing to open properly due to pink bollworms.
Rosette flowers are a characteristic diagnostic symptom of pink bollworm infestation in cotton. The larva enters the floral bud and feeds on the internal tissues, often spinning silk to tie the petals together. This prevents the flower from opening fully, giving it a twisted, rosette-like appearance. These damaged flowers usually fail to produce healthy bolls, leading to direct yield loss.

85. (A) III, IV, I, II
The pink bollworm follows a specific life cycle in northern Indian cotton zones. Adult moths emerge during the early monsoon to lay eggs. This is followed by active larval feeding inside the developing bolls. After development, some larvae pupate in the soil, while others enter a mandatory diapause inside double seeds to survive the winter and the off-season.

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water and nutrients, causing the plants to dry out and turn brownish in circular patches.

29. (A) The adults prefer to feed on the basal portion of the stem near the water level.
The green leafhopper is a significant rice pest primarily because it acts as the vector for the rice tungro virus. Unlike the brown planthopper, which concentrates at the base of the plant, green leafhoppers are typically found feeding on the leaves and the upper parts of the plant. They are strongly attracted to light and lay eggs inside the plant tissue.

30. (C) Drain the field of standing water to alter the microclimate at the base.
When circular patches of drying plants and large numbers of brownish insects are observed at the base of rice stems, it indicates a brown planthopper infestation. Draining the standing water is an effective immediate action because it reduces the humidity within the crop canopy. This change in the microclimate makes the environment less favorable for the survival and reproduction of planthoppers.

31. (C) I, II and III
Several statements about rice sap-sucking pests are factually incorrect. The brown planthopper is known to transmit viral diseases such as grassy stunt and ragged stunt. Gundhi bug infestations are most economically damaging during the milky grain stage rather than the vegetative phase. Additionally, green leafhoppers lay eggs in rows within the leaf sheath rather than in masses covered with anal hairs.

32. (C) Stunted growth and yellowing due to sap extraction.
The rice root aphid infests the underground portions of the plant, specifically targeting the roots. By extracting sap directly from the root system, the pest deprives the plant of essential nutrients and moisture. This leads to generalized symptoms of poor plant health, including stunted growth and the yellowing of leaves, which can be easily confused with nutrient deficiencies or drought.

33. (B) Reduction in grain weight and impairment of grain filling due to sap loss.
Wheat aphids typically infest the ear-heads during the grain-filling stage. By sucking sap from the developing kernels and the surrounding tissues, they compete with the plant for the carbohydrates required for grain maturation. This results in reduced grain weight, shriveled seeds, and a lower overall yield. Heavy infestations can also lead to the growth of sooty mold on honeydew.

34. (D) Polyphagous soil-dwelling seedling pest
The Gujhia weevil is a polyphagous pest that inhabits the soil and primarily attacks young seedlings of wheat and other crops. The adult weevils emerge from the soil and feed on the newly sprouted plants, often cutting them at the ground level or consuming the tender leaves. This behavior can lead to poor plant stands, requiring farmers to replant their fields.

35. (A) Complete severing of the ear-heads from the peduncle at maturity.
The wheat armyworm causes a unique type of damage during the later stages of crop growth. In addition to defoliation, the larvae have a characteristic habit of severing the ear-heads from the peduncle as the crop approaches maturity. This behavior results in the heads falling to the ground, leading to direct and significant grain loss that differs from the sap-sucking damage of aphids.

36. (C) Survives on alternate graminaceous hosts or volunteer plants.
In temperate Indian conditions, the wheat aphid survives the off-season by moving to alternate graminaceous hosts or volunteer plants that remain green. This allows the population to persist when the main wheat crop is not available. As the new wheat season begins, the aphids migrate back to the crop, where they can reproduce rapidly under favorable weather conditions.

37. (C) Overwintering adult → Egg laying → Grub feeding → Pupation
The Gujhia weevil typically completes its life cycle in a specific sequence starting with the adults that survive the off-season. These adults lay eggs in the soil, which hatch into grubs that feed on organic matter or roots. After the feeding stage, the grubs pupate in the soil before emerging as the next generation of adults to attack the new crop.

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95. (D) Jassids cause yellowing, whereas thrips cause silvering.
The damage caused by jassids and thrips on cotton can be distinguished by the color and appearance of the affected leaves. Jassids typically cause yellowing and downward curling of the leaf margins, eventually leading to hopperburn. Thrips, on the other hand, feed on the leaf tissues in a way that results in a characteristic silvering or bronzing of the leaf surface, especially on the underside.

96. (C) Destruction of alternate weed hosts off-season.
Integrated management of cotton sap-sucking pests includes several cultural practices, with the destruction of alternate weed hosts being one of the most important. Many pests like whiteflies and jassids survive the off-season on various weeds. By removing these alternate hosts near the cotton fields, farmers can significantly reduce the initial population that migrates into the new crop, delaying the onset of infestation.

97. (A) P-3, Q-2, R-1, S-4
Jute and mesta pests cause various types of damage that impact fiber quality. The jute semilooper is a defoliator that moves in a looping manner, while the stem weevil bores into the stem, leading to node formation. The Bihar hairy caterpillar is a highly polyphagous defoliator that skeletonizes leaves, and mealybugs cause stunting by extracting sap from the apical shoots.

98. (D) It acts as the primary vector for the Jute Mosaic Virus.
The jute stem weevil is a significant pest because the female excavates holes in the stem for egg-laying. The feeding of the resulting grubs causes the plant to develop hard galls or knots at the site of injury. This damage greatly reduces the tensile strength and quality of the extracted fiber. However, this weevil is not known to be a vector for the jute mosaic virus.

99. (A) Early-instar larvae that feed gregariously on leaves.
The most effective management strategy for the Bihar hairy caterpillar involves targeting the early-instar larvae. During this stage, the larvae remain clustered together and feed gregariously on the underside of the leaves. This behavior makes it easy for farmers to manually collect and destroy the infested leaves or apply localized treatments, preventing the larvae from dispersing and causing widespread defoliation in the field.

100. (C) Lacks abdominal prolegs causing it to arch its body.
The term semilooper describes the distinctive movement of certain lepidopteran larvae, such as the jute semilooper. Anatomically, these larvae lack specific pairs of abdominal prolegs, typically the first two or three pairs. This structural deficiency forces the insect to arch its body into a loop while moving across plant surfaces to navigate between feeding sites, hence the name semilooper.

101. (B) Placing bird perches in the field is entirely ineffective for managing the Bihar hairy caterpillar.
Integrated management of jute pests involves several effective strategies, including early planting and the destruction of stubbles to reduce stem weevil populations. Mechanical methods like dragging a kerosinized rope are also used. Bird perches are actually a recommended biological practice, as they encourage predatory birds to land and feed on the caterpillars, providing a natural form of pest suppression in the field.

102. (D) Tissue injury and larval feeding by beetle grubs.
The formation of hard, woody knots on jute stems is a direct physiological reaction to the injury caused by the jute stem weevil grubs. As the grubs feed within the stem tissue, the plant produces callus tissue as a defense mechanism, resulting in a gall or knot. These structures interfere with the retting process and significantly degrade the quality of the final fiber produce.

103. (C) I and III
The jute stem weevil is a small, dark-colored insect with a prominent snout, which is characteristic of the family Curculionidae. The damage is not restricted to seedlings; it can occur throughout the growth of the crop. A key biological feature is that the entire pupal stage is completed inside the stem of the host plant, emerging later as an adult to continue the cycle.

104. (C) The pre-monsoon tillering phase of the plant.
The early shoot borer of sugarcane is most destructive during the tillering stage, typically occurring before the monsoon. The larvae bore

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dropping. On chickpea, the larvae primarily target the pods, boring into them to consume the developing seeds. In both cases, the pest focuses on the most valuable reproductive parts of the plant.

48. (C) Possesses a high propensity to develop resistance to many chemicals.
Helicoverpa armigera is considered a major pest worldwide due to its broad host range and high mobility. A critical biological factor contributing to its severe pest status is its ability to rapidly develop resistance to many classes of synthetic insecticides. This necessitates the use of integrated pest management strategies that incorporate biological controls and cultural practices to maintain effective suppression.

49. (A) Both A and R are true and R is the correct explanation of A.
Planting marigold as a trap crop is a standard integrated management practice for the gram pod borer. The adult female moths are highly attracted to the marigold flowers and prefer to lay their eggs on them rather than on the main crop like tomato or chickpea. This allows farmers to concentrate and manage the pest on the trap crop rows.

50. (D) Planting susceptible trap crops to host the pest.
Integrated pest management for the gram pod borer includes several components such as the use of nuclear polyhedrovirus and the installation of bird perches. Deep summer ploughing is also essential to destroy soil-dwelling pupae. While trap crops are used, the objective is to divert the pest to a sacrificial crop rather than simply hosting it without a specific management plan.

51. (A) Integrating crop rotation, resistance, and biopesticide use.
For long-term management of the gram pod borer in multi-cropping systems, an integrated approach is the most sustainable strategy. This involves combining crop rotation to break the pest cycle, the use of resistant or tolerant varieties, and the application of biological pesticides like NPV or Bt. Such integration reduces reliance on synthetic chemicals and helps manage the development of insecticide resistance.

52. (C) Exit holes on mature pods and partially eaten grains.
The Tur pod fly is a hidden pest whose larvae feed inside the developing pods of pigeonpea. The damage is often not visible from the outside until the larvae have completed their development and formed pupae. The most characteristic diagnostic symptom is the presence of small, circular exit holes on the mature pods, accompanied by partially consumed or shriveled grains found inside.

53. (A) It is a major pest restricted exclusively to the post-harvest storage phase of pigeonpea.
The spotted pod borer is a significant field pest of pigeonpea and other legumes, not a storage pest. The larvae are known for their habit of webbing together flowers, leaves, and pods, creating a protected environment where they feed on the reproductive parts. This damage often leads to the shedding of flowers and significant reductions in the total number of pods produced.

54. (D) The pod bug (Clavigralla gibbosa)
The pod bug is a sap-sucking insect that infests pigeonpea during the pod development stage. Both adults and nymphs use their mouthparts to extract nutrients from the developing seeds, causing them to shrivel and become dark. These bugs are easily identified by their shield-like shape and the strong, unpleasant odor they emit when they are disturbed or handled.

55. (C) P-3, Q-4, R-2, S-1
Pigeonpea pests exhibit diverse feeding habits and damage symptoms. The Tur pod fly larvae feed internally and pupate inside the pod, while the spotted pod borer is characterized by the webbing of floral parts. The plume moth has hairy larvae that feed on the pod surface, and the pod bug causes damage by sucking sap directly from the developing grains.

56. (C) Being covered with spines and feeding externally on pods.
The larva of the plume moth is easily identified in pigeonpea fields by its unique morphology and feeding behavior. Unlike many other pod borers that feed entirely internally, the plume moth larva is covered with small spines or hairs and often feeds externally on the pod wall or the developing seeds. Its cryptic coloration often makes it blend in with the pod.

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mobile borers; they are relatively sedentary and remain on the leaf surface to extract sap, rather than boring into the internal tissues of the cane stalks.

114. (D) Pyrilla
The widespread presence of black sooty mold on sugarcane foliage is an indirect symptom of a heavy infestation by sap-sucking insects, most notably Pyrilla. These insects excrete large amounts of sugary honeydew while feeding. The honeydew provides a perfect substrate for the growth of the mold, which covers the leaves and interferes with photosynthesis, leading to a decline in cane vigor.

115. (C) II, III, IV and V
Effective management of sugarcane sap-sucking pests involves a combination of cultural and biological practices. Avoiding ratoon crops helps break the lifecycle of scale insects, while proper drainage and balanced fertilization reduce whitefly severity. Sett treatments protect against initial scale establishment, and the population of Pyrilla is often naturally suppressed by the environmental conditions during heavy monsoon rainfall during the season.

116. (C) Lepidoptera
Epiricania melanoleuca is a unique and highly important biological control agent in sugarcane. Unlike most common parasitoids which belong to the orders Hymenoptera or Diptera, this species is a member of the order Lepidoptera. Its larvae function as ectoparasitoids, attaching themselves to the nymphs and adults of the sugarcane leafhopper to feed on their body fluids, eventually killing the host.

117. (A) Extensive defoliation leaving only the midribs.
The tobacco caterpillar is a highly destructive pest in both nurseries and main fields. Its primary damage mechanism is extensive defoliation, where the larvae consume large amounts of leaf tissue. In severe cases, the caterpillars can strip the plants entirely, leaving only the midribs. This massive loss of leaf area directly impacts the yield and quality of the tobacco crop produced.

118. (D) Efficiency in vectoring tobacco viruses.
Myzus persicae is considered a critical threat to tobacco cultivation not only because of the direct damage it causes by sucking sap but primarily due to its role as an efficient vector for numerous plant viruses. It transmits diseases like tobacco etch and potato virus Y, which can cause severe stunting and leaf deformations, leading to far greater economic losses than sap extraction alone.

119. (B) The stem borer causes internal galling and swelling of the stem, whereas Spodoptera causes massive external defoliation.
The tobacco stem borer and Spodoptera litura differ fundamentally in their feeding sites and symptoms. The stem borer larvae bore into the midribs and eventually enter the stem, causing characteristic swelling or galling that stunts the plant. In contrast, Spodoptera litura is an external defoliator that consumes the leaf lamina from the outside, causing large holes and skeletonization of the tobacco foliage.

120. (C) Using castor as a trap crop around the field.
An effective integrated pest management strategy for Spodoptera litura in tobacco involves the use of castor as a trap crop. The female moths are highly attracted to castor and prefer to lay their egg masses on its broad leaves. This allows farmers to easily monitor the pest population and destroy the eggs or early gregarious larvae on the trap crop before they move.

121. (A) Both A and R are true and R is the correct explanation of A.
The application of nuclear polyhedrovirus is most effective against the early instars of Spodoptera litura. During these initial stages, the larvae feed gregariously on the leaf surface, which facilitates the rapid spread of the virus among the population. Their thinner cuticles also make them more susceptible to infection, ensuring a higher mortality rate before the caterpillars can disperse and cause defoliation.

122. (A) It is a highly polyphagous pest that prefers grasses over solanaceous crops.
The tobacco stem borer is a specialized pest that primarily targets solanaceous plants like tobacco. Its larvae bore into the leaf midribs and subsequently enter the stem, leading to stunting and a rosette appearance of the plant. Uprooting and destroying infested seedlings is a primary management practice. It does not prefer grasses, as its biological requirements are specifically tied to its solanaceous host plants.

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2017

24. Which taxonomic order encompasses the phytophagous mites such as spider mites and broad mites affecting horticultural ecosystems?
(A) Trombidiformes
(B) Hemiptera
(C) Thysanoptera
(D) Coleoptera

2019

25. Consider the following statements regarding pesticide residues in horticultural commodities:
I. The Pre-Harvest Interval (PHI) ensures residues fall below Maximum Residue Limits.
II. Waiting periods are universally identical for a specific pesticide across all crops regardless of climate.
III. Organochlorines generally exhibit higher environmental persistence compared to organophosphates.
IV. Botanical insecticides usually require extremely long pre-harvest intervals.
V. Good Agricultural Practices (GAP) play a crucial role in minimizing terminal pesticide residues.
Which of the above statement(s) is/are correct?
(A) I, III and V
(B) I, II, III and V
(C) II, IV and V
(D) I, III, IV and V

2004

26. When a pest population reaches the Economic Threshold Level (ETL), an inference can be drawn that without intervention, the population will likely:
(A) Naturally crash due to immediate density-dependent mortality factors
(B) Increase and eventually surpass the Economic Injury Level (EIL)
(C) Transition into a state of obligate diapause until the next season
(D) Migrate completely out of the horticultural ecosystem within 24 hours

2015

27. Which statement correctly correlates the mouthpart modification of butterflies and moths with their adult feeding behavior?
(A) Their siphoning mouthparts are adapted to draw liquid nectar
(B) Their rasping mouthparts are adapted for tearing thick fruit skin
(C) Their chewing mouthparts are utilized to bore into hardwood stems
(D) Their piercing mouthparts are adapted to extract blood from hosts

2004

28. Which of the following life cycle stages can be successfully eliminated as a targeted control strategy for pests exhibiting incomplete metamorphosis?
(A) Egg
(B) Nymph
(C) Pupa
(D) Adult

2012

29. Which of the following statements regarding the geographical distribution and host range adaptability of the diamondback moth is INCORRECT?
(A) It has a cosmopolitan distribution found wherever crucifers are grown
(B) Its distribution is highly facilitated by the movement of infested seedlings
(C) It shows specialized adaptation primarily to glucosinolate-containing plants
(D) It is a highly restricted specialist feeding only on a single plant family

2017

30. Which of the following represents the correct sequence of the infection process for persistently transmitted plant viruses by aphid vectors?
(A) Inoculation → Latent Period → Acquisition → Multiplication
(B) Acquisition → Latent Period → Retention → Inoculation
(C) Inoculation → Retention → Latent Period → Acquisition
(D) Acquisition → Inoculation → Latent Period → Retention

2001

31. In an IPM program for greenhouse whiteflies, the introduction of Encarsia formosa is applied as which specific type of control measure?
(A) Cultural control
(B) Biological control
(C) Mechanical control
(D) Physical control

2010

32. Which feature is most relevant to the successful mass trapping of the brinjal shoot and fruit borer using pheromone traps?
(A) The presence of volatile kairomones in the ripening brinjal fruit
(B) The strictly diurnal mating flight pattern of

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while they forage on the plant surface or move between the soil and the host. This visible mud coating is a highly diagnostic sign of termite activity.

132. (C) Providing irrigation to reduce water stress.
Termite damage in field crops is often exacerbated by water stress, as weakened plants are more susceptible to attack and the insects seek moisture. Providing timely irrigation is an effective cultural practice to reduce the severity of termite infestations. Maintaining adequate soil moisture creates a less favorable environment for termite foraging and helps the plants maintain their natural defenses against subterranean pests.

133. (A) Both A and R are true and R is the correct explanation of A.
In the social structure of a termite colony, the queen is the sole reproductive individual responsible for maintaining the population. The worker caste is sterile and cannot reproduce independently. Therefore, the destruction of the mound and the removal of the queen are essential steps for achieving long-term control, as the colony cannot replenish its numbers and will eventually collapse without her.

134. (D) Widespread aerial spraying of foliage protectants.
Chemical management of termites focuses on subterranean applications, as these pests are primarily soil-dwelling. Highly effective strategies include seed treatment, furrow application of granules, and soil drenching near the plant base. Widespread aerial spraying of foliage is not used for termite control because it does not reach the target insects and is inconsistent with their biological habits and the site of damage.

135. (B) Termites cultivate fungi to aid in predigestion.
Many species of Odontotermes termites engage in a symbiotic relationship with specific fungi. They cultivate these fungi on specialized "fungus combs" made of partially digested plant material within the mound. The fungi break down the complex cellulose and lignin into more easily digestible nutrients. This process allows the termites to extract maximum energy from their food source and supports the entire colony's nutritional needs.

136. (C) Feed aggressively on a vast array of different plant species and families.
The red hairy caterpillar is described as polyphagous because it has an exceptionally broad host range. It is capable of feeding on and damaging hundreds of different plant species across various families, including groundnut, pulses, and many cereal crops. This ability to utilize diverse food sources allows the pest to survive and thrive in varied agricultural landscapes, especially during the monsoon season.

137. (D) The pest typically completes 5-6 overlapping generations per year without any diapause.
The red hairy caterpillar is a highly seasonal pest whose emergence is synchronized with the first monsoon rains. The adults are attracted to light, and the pupae survive the dry season by undergoing a long diapause in the soil. Unlike many other pests, it typically completes only one or two generations per year, with the rest of the time spent in the pupal stage.

138. (A) Dig a trench dusted with insecticide.
To stop the rapid migration of hairy caterpillars between fields, digging a trench is the most effective mechanical intervention. The trench should be about 30 centimeters deep with steep sides to prevent the caterpillars from crawling out. Dusting the bottom of the trench with a suitable insecticide ensures that the trapped larvae are killed, providing a highly effective barrier against their movement.

139. (C) P-2, Q-1, R-4, S-3
Different species of hairy caterpillars are identified by their host preferences and biological features. The Bihar hairy caterpillar is a highly polyphagous pest of jute and oilseeds, while the red hairy caterpillar is a major pest of dryland groundnut. The castor hairy caterpillar possesses irritating hairs, and the sunnhemp hairy caterpillar is a specialized feeder on Crotalaria species in agricultural areas.

140. (B) Feeding gregariously, skeletonizing leaves.
The early larval stages of red and Bihar hairy caterpillars are characterized by their gregarious feeding behavior. Upon hatching, the young larvae remain clustered together on the underside of leaves, consuming the green chlorophyllous tissue while leaving the veins intact. This creates a skeletonized appearance on the foliage, which

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159. (D) The pest density where control cost equals value saved.
The Economic Injury Level is a foundational concept in pest management that integrates biological and economic variables. It represents the specific pest density at which the financial loss caused by the pest equals the total cost of the management intervention. This calculation ensures that control measures are economically justified and prevents unnecessary chemical applications in various agricultural production systems.

160. (C) An antifeedant, growth regulator, and deterrent.
Botanical insecticides derived from the neem tree contain azadirachtin, which disrupts the normal growth and feeding behavior of various agricultural pests. Instead of immediate toxicity, these compounds function through complex modes of action such as antifeedant properties and growth regulation. This makes them highly suitable for sustainable integrated pest management programs that prioritize environmental safety and natural enemy conservation.

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150. (D) Occurrence of major pre-monsoon showers.
The mass emergence of adult white grubs is a highly synchronized event triggered by the first significant pre-monsoon or monsoon showers. The moisture softens the soil, allowing the chafer beetles to exit their subterranean cells and take flight. This emergence is critical for mating and subsequent oviposition, making it the most effective window for implementing area-wide management strategies for the pest.

151. (B) Adults congregate on host trees for mating at night.
Managing white grubs is most effective when targeting adult chafer beetles during their mass emergence phase. These adults typically congregate on specific host trees, such as neem or acacia, for mating and feeding immediately following pre-monsoon rains. By focusing control measures on these concentrated populations, the subsequent infestation of groundnut or sugarcane fields by larvae can be significantly reduced.

152. (C) Scarabaeidae
Taxonomically, white grubs are the larval stage of beetles belonging to the family Scarabaeidae. This family is characterized by beetles with distinctive lamellate antennae and larvae that are typically C-shaped and live in the soil or decaying organic matter. Many species within this family are significant agricultural pests because their larval feeding can cause extensive damage to the root systems of various crops.

153. (D) Use of soil application of fungi or granular chemicals.
Because white grubs are subterranean pests, their management requires strategies that target the soil environment. This includes the application of granular insecticides or entomopathogenic fungi like Metarhizium anisopliae into the soil during field preparation or at the time of sowing. These methods ensure that the control agents come into direct contact with the larvae residing below the soil surface.

154. (A) A brown head, thoracic legs, and "C"-shaped body.
The white grub larva is easily identified by its distinct morphological features. It possesses a prominent, sclerotized brown head capsule with strong mandibles and three pairs of well-developed thoracic legs. The body is fleshy, white, and typically held in a "C"-shaped position. This morphology is characteristic of scarabaeid larvae and is adapted for a subterranean life feeding on plant roots.

155. (B) The prophylactic, scheduled application of broad-spectrum chemical insecticides.
Integrated pest management is based on the integration of multiple control strategies, including cultural, biological, and physical methods. A foundational principle is that chemical insecticides should only be used as a last resort, based on regular scouting and established economic threshold levels. Prophylactic or scheduled spraying is discouraged, as it can lead to insecticide resistance, pest resurgence, and environmental degradation.

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156. (A) A trap crop to attract spotted bollworms.
In cotton integrated pest management, okra is frequently utilized as a trap crop for the spotted bollworm. The adult moths are highly attracted to the succulent tissues of okra and prefer to lay their eggs on it rather than on the cotton plants. This allows farmers to concentrate the pest population on the border rows, where they can be more easily managed or destroyed.

157. (A) It parasitizes and prevents the hatching of lepidopteran eggs.
The utilization of Trichogramma chilonis serves as a primary biological control method targeting the egg stage of various lepidopteran pests. These minute wasps deposit their own eggs inside the host eggs, effectively preventing the development and hatching of destructive larvae. This intervention is critical for maintaining pest populations below economic thresholds without using synthetic chemicals in diverse cropping systems.

158. (C) Bacillus thuringiensis (Bt) is primarily effective against the adult stage of sap-sucking insects.
Bacillus thuringiensis is a specialized entomopathogenic bacterium primarily effective against the larval stages of lepidopteran insects. It functions as a stomach poison that must be ingested to disrupt the gut lining of caterpillars. It is not effective against the adult stages of sap-sucking insects, which have different physiological systems and feeding mechanisms compared to the targeted lepidopteran larvae.

123. (B) Physical crowding and tactile stimulation of nymphs.
The desert locust exhibits a remarkable biological phenomenon known as phase polyphenism. The transition from a solitary existence to a highly gregarious swarming state is primarily triggered by increased population density. Physical crowding leads to frequent tactile stimulation, especially on the hind legs, which induces physiological and behavioral changes that cause individuals to aggregate into cohesive and extremely mobile swarms.

124. (B) Changes in serotonin and juvenile hormone dynamics.
The fundamental mechanism driving phase polymorphism in locusts is hormonal and neurochemical. Increased physical contact among individuals triggers a rapid spike in serotonin levels in the brain, which initiates the change from solitary to gregarious behavior. This process is further modulated by other hormones, including juvenile hormone, which influence the distinct physiological and color changes characteristic of the different locust phases.

125. (A) The Migratory Locust (Locusta migratoria) is entirely extinct and has not been recorded in India for over a century.
While the desert locust is the most famous swarming species in India, other species like the migratory locust and the Bombay locust also exist. The migratory locust is not extinct in India; however, it only occasionally forms swarms under specific environmental conditions. Most of the time, it remains in its solitary phase, which is less noticeable and does not cause widespread agricultural damage.

126. (C) Aerial application of ULV insecticides onto swarms.
For immediate and large-scale management of approaching locust swarms, aerial application of ultra-low volume insecticides is the most effective method. This technique allows for the rapid coverage of large areas and targets both flying swarms and settled populations. ULV formulations are designed to be highly concentrated and effective at very low dose rates, making them suitable for the urgent requirements of locust control operations.

127. (A) P-3, Q-4, R-1, S-2
Locust biology involves distinct phases and developmental stages that define their behavior. The solitaria phase describes individualistic insects with cryptic colors, while the gregaria phase involves swarming behavior and bright coloration. Hopper bands are groups of marching nymphs without wings, and fledglings are young adults that have recently molted and possess soft wings that are not yet hardened for long-distance flight.

128. (C) Moist, sandy soils at a depth of about 5-10 cm.
The desert locust has specific requirements for oviposition to ensure the survival of its eggs. Females prefer to lay their eggs in moist, sandy soils, usually at a depth of 5 to 10 centimeters. The moisture is essential for the eggs to absorb water and develop properly. This preference makes certain desert and semi-arid regions ideal breeding grounds following seasonal rainfall.

129. (B) Digestion of cellulose with the help of gut biota.
Termites are significant pests of wheat and sugarcane primarily because they feed on the cellulose found in plant tissues. To digest this complex carbohydrate, they rely on a specialized symbiotic relationship with protozoa and bacteria in their gut. This foraging behavior allows them to utilize dead or living plant material as a source of energy, leading to the destruction of agricultural crops.

130. (D) Reproductives (king and queen), workers, and soldiers.
Termites are eusocial insects with a highly organized caste system. A typical colony consists of the reproductive pair, known as the king and queen, who are responsible for populating the mound. The workers perform all the foraging, nest building, and care for the young, while the soldiers possess specialized mandibles or chemical defenses to protect the colony from predators like ants.

131. (A) Constructing earthen sheeting over the plants.
Termite damage can be distinguished from other root-feeding pests by the presence of earthen sheeting or galleries. Termites are highly sensitive to desiccation and construct these mud structures to maintain a humid environment

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CHAPTER 12

Pests of Horticultural Crops and Their Management

2012

1. Which of the following best defines the Economic Threshold Level (ETL) in the context of pest management in horticultural ecosystems?
(A) The pest density at which control measures must be taken to prevent the population from reaching the Economic Injury Level
(B) The maximum pest population density that a specific horticultural crop can support without any quantifiable yield loss
(C) The minimum pest population density that causes economic damage and justifies the operational cost of chemical control
(D) The specific number of individual pests required to cause permanent structural damage to the primary host plant

2005

2. Which type of arthropod mouthparts is primarily associated with the physical scraping of leaf tissues and subsequent sucking of the exuding sap, resulting in silvery or whitish patches?
(A) Piercing and sucking
(B) Chewing and biting
(C) Rasping and sucking
(D) Siphoning

2015

3. In the context of horticultural insect bionomics, which characteristic strictly differentiates holometabolous development from hemimetabolous development?
(A) The presence of a pupal stage involving complete morphological reorganization
(B) The development of wings externally through several successive nymphal instars
(C) The requirement of an obligatory diapause phase during the winter season
(D) The presence of chewing mouthparts in both the juvenile and adult stages

2005

4. Wind currents play a significant role in the passive dispersal of which of the following horticultural pests over large geographic areas?
(A) Mango stem borer
(B) Banana rhizome weevil
(C) Red palm weevil
(D) Mustard aphid

2009

5. Consider the following statements regarding arthropod vectors in horticultural crops:
I. Aphids primarily transmit non-persistent plant viruses.
II. Whiteflies are the exclusive vectors of all known Tospoviruses.
III. Thrips are the primary vectors of Peanut Bud Necrosis Virus.
Which of the above statement(s) is/are correct?
(A) II only
(B) I and III
(C) I and II
(D) III only

2002

6. Which cultural control practice involves growing a highly preferred susceptible crop alongside the main commercial crop to divert pest populations?
(A) Mulching
(B) Crop rotation
(C) Trap cropping
(D) Solarization

2013

7. The Epilachna beetle causes severe damage to solanaceous vegetables through which specific feeding behavior?
(A) Mining the epidermal layers of the fruit during the early development stages
(B) Boring into the main stem and causing the plant to wilt under field conditions
(C) Piercing the vascular bundles to extract large quantities of phloem sap
(D) Scraping leaf tissue leaving a characteristic skeletonized network of veins

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is a key diagnostic sign for implementing timely management interventions in the field.

141. (A) Dense covering of long and irritating hairs.
Hairy caterpillars are well-protected from many generalist predators by their dense covering of long hairs. These hairs can be highly irritating or even toxic, acting as a significant physical and chemical deterrent to birds and other potential predators. This defense mechanism allows the caterpillars to feed openly on the plant canopy during the day without facing high levels of predation.

142. (C) Nocturnal, soil-dwelling seedling pests
Cutworms are functionally classified as nocturnal, soil-dwelling pests that primarily attack young seedlings. They remain hidden in the soil or under debris during the day to avoid heat and predators, emerging at night to feed. Their characteristic habit of cutting the stems of young plants at or just below the soil level makes them particularly destructive during the early stages of crop establishment.

143. (D) Cutworms sever plants, while armyworms strip foliage.
Cutworms and armyworms differ significantly in their feeding behavior and the resulting crop damage. Cutworms are known for their habit of severing the stems of young seedlings at the ground level, which often results in the death of the entire plant. In contrast, armyworms are primarily defoliators that feed on the leaves, often stripping the foliage but leaving the main stem intact.

144. (C) Broadcasting poison bait during the late evening hours.
Broadcasting poison baits is a recommended practice for managing cutworms in fields. Since these pests are nocturnal and feed on the soil surface at night, applying the bait in the late evening ensures that it is fresh and accessible when the larvae emerge. These baits typically consist of an attractant like wheat bran mixed with a suitable insecticide to control the population.

145. (B) The eggs are laid exclusively deep within the vascular bundles of the host plant.
The black cutworm is a well-known pest with several distinct biological traits. The larvae curl into a characteristic 'C' shape when disturbed and hide in the soil during the day. However, their eggs are not laid deep within the plant tissues; instead, they are typically deposited on the soil surface, on lower leaves, or on plant debris in the field.

146. (D) Greasy cutworm (Agrotis ipsilon)
A diagnostic symptom of greasy cutworm infestation in chickpea is the presence of seedlings that have been cleanly severed at the soil level. The larvae are nocturnal and remain hidden in the soil during the day, emerging at night to feed. Their greasy, dark-grey appearance and the characteristic damage to the collar region confirm the identity of this pest in newly sown fields.

147. (A) Pupae enclosed in earthen cells within the soil matrix.
In many temperate and subtropical climates, cutworm species survive the winter or the off-season by undergoing a period of dormancy. This is most commonly achieved by the mature larvae burrowing deep into the soil to form a pupal cell. These earthen cells provide protection from extreme temperatures and predators, allowing the pupae to remain safe until favorable conditions trigger adult emergence.

148. (C) Delayed harvesting of the previous crop forces the pest to starve.
Cultural control of cutworms involves practices like early ploughing to expose larvae and removing weeds to reduce egg-laying sites. Using well-decomposed manure is also important to avoid attracting the pests. However, delayed harvesting of the previous crop is not a recommended control measure, as it often provides a continuous food source and allows the pest population to build up for the next season.

149. (A) Feeding on the root system by "C"-shaped larvae.
White grubs are the larvae of chafer beetles and are major subterranean pests of groundnut and sugarcane. They possess characteristic "C"-shaped bodies and live in the soil, where they feed aggressively on the plant root system. This feeding destroys the roots, preventing the uptake of water and nutrients, which eventually leads to the wilting and death of the infested plants.

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(B) II and III
(C) I, III and IV
(D) I and IV

2025

16. Which of the following factors is the LEAST RELEVANT to the population dynamics of the grape flea beetle during the pruning season?
(A) Availability of sprouting buds
(B) Ambient temperature and relative humidity
(C) The timing of the vine pruning operation
(D) The specific color of the mature grape berries

2022

17. Which of the following pairs of coconut pests and their primary nature of damage is INCORRECTLY matched?
(A) Eriophyid mite - Boring deep tunnels into the primary roots of the palm
(B) Rhinoceros beetle - Cutting unopened leaves resulting in geometric V-shaped damage
(C) Red palm weevil - Grubs boring into the trunk and destroying the apical growing point
(D) Black-headed caterpillar - Defoliating mature leaflets leaving only the midribs

2015

18. Based on the bionomics of the coffee berry borer (Hypothenemus hampei), which integrated management strategy is most biologically appropriate?
(A) Flooding the coffee plantation to drown the root-feeding larvae in the soil
(B) Applying broad-spectrum systemic insecticides to the leaves during flowering
(C) Timely harvesting and removal of gleaned berries from the soil surface
(D) Deploying yellow sticky traps to capture the nocturnal actively flying larvae

2005

19. The cashew stem and root borer (Plocaederus ferrugineus) predominantly infests which specific region of the host tree?
(A) The collar region of the trunk and the primary structural roots
(B) The newly formed terminal shoots and tender leaves of the cashew
(C) The inflorescence and developing cashew apples during the fruiting phase
(D) The mesophyll layers of mature foliage throughout the upper canopy

2012

20. Match the tree spice pests (List I) with their typical nature of damage (List II).
List I: (Pests)
P. Cardamom thrips
Q. Cardamom shoot borer
R. Black pepper pollu beetle
S. Cinnamon butterfly
List II: (Nature of Damage)
1. Defoliation of tender foliage
2. Boring into pseudostems causing dead heart
3. Hollowing out of berries leaving outer shells
4. Scab formation and corky encrustations on capsules
(A) P-4, Q-2, R-3, S-1
(B) P-3, Q-1, R-4, S-2
(C) P-2, Q-3, R-1, S-4
(D) P-1, Q-4, R-2, S-3

2013

21. Which term best describes the feeding phase of the coriander aphid (Hyadaphis coriandri) that leads to severe stunting and reduced seed yield?
(A) Nectar gathering
(B) Phloem sap extraction
(C) Epidermal grazing
(D) Xylem tissue boring

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2005

22. The rose chafer beetle (Oxycetonia versicolor) causes primary economic loss to commercial roses by feeding on which plant part?
(A) The primary taproot system and lateral roots found deep within the soil
(B) The woody stem of the rose bush near the ground level or graft union
(C) The reproductive organs and delicate petals of open rose flowers
(D) The fully expanded lower leaves of the bush during the vegetative stage

2009

23. What is the direct physiological effect of heavy fungus gnat larval infestations in protected foliage ornamentals?
(A) Rapid transmission of persistent plant viruses within the greenhouse
(B) Extensive mining of the upper leaf canopy causing premature leaf fall
(C) Deposition of large quantities of honeydew on the developing floral buds
(D) Injury to root hairs leading to wilting and reduced nutrient uptake

2008

8. The Diamondback moth, a major pest of cruciferous vegetables, typically pupates in which of the following microhabitats?
(A) In a loose silken cocoon attached to the lower surface of host leaves
(B) Deep inside the soil at a depth of 15 to 20 centimeters below the surface
(C) Inside the main taproot system of the developing cabbage or cauliflower plant
(D) Within the primary stems of alternate solanaceous weed hosts found in the area

2006

9. What is the primary cause of fruit rotting following an infestation by the melon fruit fly in cucurbitaceous crops?
(A) Introduction of phytopathogenic viruses into the fruit tissue during oviposition
(B) Secondary infections entering through oviposition punctures and larval galleries
(C) Depletion of water content due to excessive adult feeding on the fruit surface
(D) Chemical toxins injected by the adult female that degrade the fruit pericarp

2025

10. Each of the following questions consists of two statements, an Assertion (A) and a Reason (R). Select the correct answer using the codes given below:
Assertion (A): The spotted bowlworm (Earias vittella) causes severe damage to okra by boring into terminal shoots and developing fruits.
Reason (R): Earias vittella exclusively possesses piercing and sucking mouthparts that allow it to extract sap from the vascular bundles.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2023

11. Which of the following damage symptoms is most indicative of onion thrips (Thrips tabaci) infestation in bulb crops?
(A) Silvery-white blotches on leaves that eventually dry up and distort
(B) Deep circular holes bored into the center of the developing onion bulb
(C) Complete defoliation of the lower plant canopy within 48 hours
(D) Excessive honeydew production leading to heavy sooty mold on bulbs

2023

12. Which statement regarding the mango nut weevil (Sternochetus mangiferae) is INCORRECT?
(A) The developing grub feeds directly on the cotyledons inside the mango stone
(B) The pest completes its entire larval and pupal development within the fruit
(C) The adult female lays eggs exclusively on the bark of the main tree trunk
(D) The adult weevil emerges by chewing a circular hole through the stone and pulp

2021

13. Which of the following symptoms represents the typical damage caused by the citrus leaf miner (Phyllocnistis citrella)?
(A) Premature fruit drop accompanied by extensive tunneling in the fruit pulp
(B) Deeply ringed bark near the soil surface leading to tree girdling
(C) Extensive skeletonization of older leaves leaving only the midrib intact
(D) Serpentine silvery galleries on the tender foliage of the citrus tree

2011

14. What is a primary disadvantage of relying exclusively on chemical insecticides for the management of the banana aphid (Pentalonia nigronervosa)?
(A) Chemical insecticides often enhance the nutritional quality of the banana pseudostem
(B) The aphid rapidly develops physical barriers such as a thickened exoskeleton
(C) It fails to prevent the spread of the virus once initial inoculation occurs
(D) Chemical applications induce immediate dormancy in the aphid population

2015

15. Consider the following statements regarding temperate fruit pests:
I. The San Jose scale overwintering stage is typically the black cap stage.
II. The Woolly apple aphid forms conspicuous white cottony colonies on branches and roots.
III. The Codling moth primarily causes damage by mining the leaves of apple trees.
IV. The Peach leaf curl aphid induces the formation of pseudo-galls on the foliage.
Which of the above statement(s) is/are correct?
(A) I, II and IV

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the adult males
(C) The deployment of traps immediately after the first fruit harvest
(D) The use of the species-specific female sex pheromone blend

2003

33. Identify the correct pair of a cruciferous pest and its predominant overwintering or aestivation mechanism.
(A) Mustard sawfly - Overwinters as a pupa in a cocoon in the soil
(B) Cabbage butterfly - Aestivates as an actively feeding adult beetle
(C) Diamondback moth - Overwinters as a mobile first-instar leaf larva
(D) Mustard aphid - Overwinters entirely as a winged adult in the canopy

2022

34. The red pumpkin beetle (Aulacophora foveicollis) primarily inflicts economic damage to cucurbits during which growth stage of the crop?
(A) Post-harvest storage in the warehouse
(B) Mid-ripening of the mature fruits
(C) Seedling and early vegetative stages
(D) Post-senescence of the main vines

2002

35. Consider the following statements regarding malvaceous pests:
I. The okra fruit borer exclusively damages the foliage and spares the fruits.
II. Jassids cause phytotoxemia resulting in yellowing and curling of leaf margins.
III. Whiteflies serve as the primary vector for Yellow Vein Mosaic Virus in okra.
Which of the above statement(s) is/are correct?
(A) II and III
(B) I only
(C) I and II
(D) III only

2003

36. The leguminous pod borer (Maruca vitrata) is characterized by spinning a protective web. What structural components does this web primarily enclose?
(A) The primary root system and the lower stem of the host plant
(B) Only the fully mature, dried seeds found within the pods
(C) The cotyledons during the hypogeal germination phase of growth
(D) Tender shoots, flower buds, and the developing pods

2015

37. What is a notable advantage of utilizing localized bait sprays (attractant plus toxicant) over blanket chemical sprays for the management of the mango fruit fly?
(A) It guarantees the complete eradication of all life stages of the fruit fly in the orchard
(B) It reduces non-target exposure and overall pesticide load in the orchard
(C) It enhances the photosynthetic efficiency of the mango leaves after application
(D) It simultaneously controls all fungal pathogens present on the fruit surface

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2004

38. Which of the following pairs regarding citrus pests and their management is INCORRECTLY matched?
(A) Citrus psylla - Application of systemic insecticides during new flush
(B) Fruit sucking moths - Deployment of poison baits and nocturnal illumination
(C) Citrus butterfly - Using pheromones to disrupt the larval pupation
(D) Citrus leaf miner - Pruning and destruction of severely mined leaves

2013

39. Which biological control agent is most appropriate for the sustainable management of the papaya mealybug (Paracoccus marginatus)?
(A) Trichogramma chilonis
(B) Aceria guerreronis
(C) Cryptolaemus montrouzieri
(D) Acerophagus papayae

2002

40. Each of the following questions consists of two statements, an Assertion (A) and a Reason (R). Select the correct answer using the codes given below:
Assertion (A): The codling moth (Cydia pomonella) is a major constraint in the commercial production of apples in temperate regions.
Reason (R): The codling moth larvae feed externally on the apple skin, causing superficial cosmetic blemishes that reduce market value.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.

resistance.
IV. The Maximum Residue Limit (MRL) is a standardized safety threshold enforced by regulatory agencies.
Which of the above statement(s) is/are correct?
(A) I, III and IV
(B) II, III and IV
(C) I, III and IV
(D) I, II and III

2005

76. To accurately calculate the Economic Injury Level (EIL) of a horticultural pest, one must fundamentally integrate the cost of the control measure with the:
(A) Exact geographic coordinates of the orchard
(B) Density of non-target pollinator species
(C) Market value of the crop and the proportionate damage caused per pest
(D) Overall soil pH and texture

2015

77. The term "mining" in the context of insect damage refers strictly to the feeding activity that occurs:
(A) Below the soil surface targeting the root nodules
(B) Deep within the structural woody tissues of the trunk
(C) Externally on the hardened seed coat
(D) Between the epidermal layers of the foliage

2011

78. In holometabolous insects, the biologically quiescent stage primarily dedicated to tissue reorganization and development of adult appendages is the:
(A) Larva
(B) Nymph
(C) Pupa
(D) Egg

2025

79. Which characteristic is LEAST LIKELY to facilitate rapid geographical dispersion of a horticultural pest?
(A) Parthenogenetic reproduction capabilities
(B) A monophagous diet restricted to a rare, endemic plant
(C) High dispersal capacity via strong flight
(D) Microscopic size allowing for wind dispersion

2009

80. Match the disease vectors (List I) with the horticultural pathogens they transmit (List II).
List I: (Vectors)
P. Aphids
Q. Thrips
R. Whiteflies
S. Leafhoppers
List II: (Pathogens)
1. Tomato Spotted Wilt Virus
2. Papaya Leaf Curl Virus
3. Little Leaf of Brinjal (Phytoplasma)
4. Banana Bunchy Top Virus
(A) P-4, Q-1, R-2, S-3
(B) P-3, Q-2, R-4, S-1
(C) P-1, Q-4, R-3, S-2
(D) P-2, Q-3, R-1, S-4

2003

81. The deployment of light traps in an IPM program primarily targets which specific group of insects?
(A) Nocturnal phototropic adult insects
(B) Diurnal predatory wasps
(C) Soil-dwelling root grubs
(D) Wingless aphids

2009

82. Which of the following is an effective cultural method to reduce the incidence of the potato tuber moth (Phthorimaea operculella)?
(A) Shallow planting and leaving soil cracks unsealed
(B) Continuous irrigation to waterlog the field
(C) Earthing up to prevent female access to tubers
(D) Applying heavy doses of synthetic nitrogenous fertilizers

2023

83. The mustard aphid (Lipaphis erysimi) reduces crop yield primarily by:
(A) Sap-sucking from flowers and pods, leading to poor seed formation
(B) Defoliating the entire plant within a week
(C) Boring into the main taproot and causing lodging
(D) Secreting phytotoxic enzymes that induce systemic necrosis

2018

84. Which stage of the fruit fly (Bactrocera spp.) is typically targeted by cuelure-based parapheromone traps in cucurbit fields?
(A) Adult females searching for oviposition sites
(B) Emerging larvae from the soil
(C) Pupae undergoing metamorphosis
(D) Adult males seeking mates

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2015

49. Which of the following statements regarding phytophagous mites in horticultural crops is INCORRECT?
(A) They cause damage strictly through chewing and biting plant tissues
(B) They possess three pairs of legs during their larval stage
(C) Their populations often surge following use of synthetic pyrethroids
(D) False spider mites generally do not produce extensive webbing

2005

50. Match the pesticide terminology (List I) with its appropriate definition (List II).
List I: (Terminology)
P. Waiting period (PHI)
Q. Maximum Residue Limit (MRL)
R. Acceptable Daily Intake (ADI)
S. Lethal Dose (LD50)
List II: (Definition)
1. The maximum legally permitted concentration of a pesticide on a crop
2. The amount of chemical required to kill 50% of a test population
3. The daily exposure level of a residue considered safe over a lifetime
4. The minimum time required between the last application and harvest
(A) P-4, Q-1, R-3, S-2
(B) P-3, Q-2, R-1, S-4
(C) P-1, Q-4, R-2, S-3
(D) P-2, Q-3, R-4, S-1

2004

51. In pest population dynamics, what distinguishes the Economic Injury Level (EIL) from the general equilibrium position (GEP) of an insect?
(A) EIL represents the threshold of economic loss, whereas GEP is the average long-term population density in the absence of control
(B) EIL fluctuates daily, whereas GEP represents a strictly fixed numerical value
(C) GEP applies only to holometabolous insects, whereas EIL applies to hemimetabolous insects
(D) GEP represents the population density after a chemical application, whereas EIL is the initial density

2014

52. The characteristic "shot-hole" symptom on plant leaves is most commonly associated with which type of pest mouthparts?
(A) Rasping and sucking
(B) Piercing and sucking
(C) Sponging
(D) Chewing and biting

2021

53. The transition from larva to pupa in holometabolous horticultural pests is primarily regulated by a decrease in the titer of which hormone?
(A) Ecdysone
(B) Juvenile Hormone
(C) Prothoracicotropic hormone (PTTH)
(D) Bursicon

2023

54. Which inherent biological trait significantly enhances a pest's host range adaptability across diverse horticultural ecosystems?
(A) Strict monophagy
(B) Lack of functional wings in the adult stage
(C) High genetic plasticity and enzymatic detoxification mechanisms
(D) Obligate reliance on a single specific symbiont for digestion

2025

55. Consider the following statements regarding the role of arthropods as disease vectors:
I. Bacterial wilt in cucurbits is efficiently transmitted by the red pumpkin beetle.
II. Papaya ringspot virus is persistently transmitted by mealybugs.
III. Banana aphid transmits Banana Bunchy Top Virus in a circulative manner.
IV. Leafhoppers are major vectors for phytoplasma diseases in horticultural crops.
V. Citrus greening (HLB) is primarily transmitted by the citrus butterfly.
Which of the above statement(s) is/are correct?
(A) I, III and IV
(B) II, IV and V
(C) I, III and IV
(D) II, III and V

2010

56. What constitutes the primary mechanism of action for physical pest control using soil solarization in horticultural fields?
(A) Elevation of soil temperature using clear mulch to kill pests and pupae
(B) Enhancement of beneficial soil microbial populations through selective feeding
(C) Direct physical crushing of insect eggs via heavy machinery

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(D) Creation of an anoxic environment by flooding the field with cold water

2024

57. The hadda beetle (Henosepilachna vigintioctopunctata) is a major pest of which group of crops?
(A) Malvaceous crops
(B) Solanaceous crops
(C) Cruciferous crops
(D) Leguminous crops

2022

58. Cabbage butterfly (Pieris brassicae) infestations are most devastating because the larvae:
(A) Mine the vascular cambium of the main stem
(B) Are gregarious in early instars and skeletonize leaves rapidly
(C) Transmit the devastating Turnip Mosaic Virus efficiently
(D) Feed exclusively on the root hairs of seedlings

2008

59. The structural modification of placing a protective paper cover around developing bitter gourd fruits is designed to prevent damage by which specific pest?
(A) Melon fruit fly
(B) Red pumpkin bug
(C) Pumpkin caterpillar
(D) Two-spotted spider mite

2022

60. Arrange the typical damage progression of the shoot and fruit borer (Leucinodes orbonalis) in eggplant:
I. Wilting and drooping of terminal vegetative shoots
II. Entry of the young larva into the tender shoot
III. Shifting of infestation and boring into developing fruits
IV. Rotting of fruits due to secondary pathogenic infection
(A) I, II, III, IV
(B) II, I, III, IV
(C) II, III, I, IV
(D) III, II, I, IV

2016

61. Which pest is notorious for acting as a vector for the Tomato Spotted Wilt Virus (TSWV) which occasionally cross-infects leguminous vegetables?
(A) Whiteflies
(B) Aphids
(C) Leafhoppers
(D) Thrips

2009

62. Which life stage of the mango mealybug (Drosicha mangiferae) typically descends to the soil to lay eggs?
(A) First instar nymph
(B) Winged adult male
(C) Wingless adult female
(D) Pupa

2009

63. The sooty mold commonly observed on citrus foliage following a severe blackfly (Aleurocanthus woglumi) infestation is a direct result of:
(A) Spores carried by the adult blackfly
(B) Honeydew excretion serving as a substrate for Capnodium fungi
(C) Chemical toxins injected into the leaf sap
(D) Necrotic cell death of the epidermal tissue

2013

64. A significant advantage of using pseudostem trapping in the management of the banana weevil (Cosmopolites sordidus) is that it:
(A) Eliminates the need for any chemical nematicides
(B) Directly kills the eggs laid deep within the rhizome
(C) Prevents the dispersal of the banana aphid
(D) Aggregates adults using host kairomones without environmental pollution

2023

65. Consider the following statements regarding pests of temperate fruits:
I. Woolly apple aphid infestations cause gall-like swellings on both roots and stems.
II. San Jose scale reproduces exclusively via oviparity (egg-laying).
III. Peach leaf curl aphid overwinters as eggs on the bark of the host tree.
Which of the above statement(s) is/are correct?
(A) I and III
(B) II and III
(C) I and II
(D) I only

2003

66. Which aspect of the grape flea beetle's biology makes foliar sprays immediately after pruning highly relevant for its management?
(A) The larvae primarily attack the roots during this phase
(B) The pupae emerge directly from the pruning

NODIA

cuts
(C) The adults congregate to feed on newly emerging sprouting buds
(D) The eggs are laid inside the dormant woody tissue

2022

67. Identify the INCORRECT pair regarding coconut pests and their management techniques.
(A) Black-headed caterpillar - Application of systemic fungicides to the trunk
(B) Rhinoceros beetle - Placement of phorate granules in leaf axils
(C) Red palm weevil - Root feeding of monocrotophos or other approved systemic insecticides
(D) Eriophyid mite - Application of botanical acaricides like azadirachtin

2013

68. The application of Beauveria bassiana for the control of the coffee berry borer operates on which fundamental concept?
(A) Chemical disruption of the pest's nervous system
(B) Competitive exclusion for food resources
(C) Hormonal disruption preventing pupation
(D) Fungal infection of the insect cuticle and internal colonization

2001

69. The tea mosquito bug causes damage to cashew plantations primarily by:
(A) Boring deep into the trunk to construct pupal galleries
(B) Piercing tender flush and floral branches, resulting in blackened lesions
(C) Feeding on the fibrous root system leading to sudden wilting
(D) Dispersing fungal spores into the main vascular tissue

2023

70. Each of the following questions consists of two statements, an Assertion (A) and a Reason (R). Select the correct answer using the codes given below:
Assertion (A): Cardamom thrips (Sciothrips cardamomi) cause a corky, scab-like encrustation on the surface of cardamom capsules.
Reason (R): Thrips possess rasping and sucking mouthparts that lacerate the epidermal cells of the capsule, leading to localized tissue necrosis.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2001

71. The rhizome scale (Aspidiella hartii) is a major constraint in the storage of which seed/rhizome spices?
(A) Coriander and fennel
(B) Cumin and fenugreek
(C) Cardamom and black pepper
(D) Ginger and turmeric

2021

72. Which open-field flower pest causes severe damage by directly feeding on the developing capitulum or floral head, often leading to total loss of marketability?
(A) Rose chafer beetle
(B) Serpentine leaf miner
(C) Chrysanthemum aphid
(D) Jasmine bud worm

2009

73. High relative humidity and poor ventilation in a greenhouse most directly cause an explosive population increase in which group of pests?
(A) Cutworms
(B) Fungus gnats
(C) Grasshoppers
(D) Desert locusts

2009

74. Which morphological feature distinguishes the order Acarina (mites) from the class Insecta?
(A) Presence of distinct head, thorax, and abdomen
(B) Lack of antennae and presence of four pairs of legs in the adult stage
(C) Presence of compound eyes and functional wings
(D) Obligate presence of chewing mouthparts in all life stages

2003

75. Consider the following statements regarding pesticide safe use:
I. Waiting periods are strictly calculated based on the pesticide degradation curve for a specific crop.
II. Contact insecticides require much longer pre-harvest intervals than highly persistent systemic insecticides.
III. Repeated application of sublethal pesticide doses promotes the development of insect

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(D) A is false but R is true.

2001

41. Severe infestation of pomegranate fruits by the pomegranate butterfly (Deudorix isocrates) directly causes which of the following secondary effects?
(A) Rapid root decay leading to sudden plant death
(B) Fungal or bacterial invasion leading to fruit rot and dropping
(C) Hypertrophy of the leaf petioles in the upper canopy
(D) Increased fruit size due to growth hormone stimulation by larvae

2010

42. In the context of arecanut pests, what defines the damage mechanism of the spindle bug (Carvalhoia arecae)?
(A) It chews extensive galleries through the mature fibrous stem of the palm
(B) It feeds on sap of tender spindle leaves causing necrotic patches
(C) It constructs mud galleries over the surface of the developing nuts
(D) It attacks the root system, causing nutritional deficiency symptoms

2024

43. When comparing the damage caused by the tea mosquito bug to that of the white stem borer in coffee, which distinction is correct?
(A) The bug causes shoot lesions while the borer mines the woody stem
(B) The tea mosquito bug targets the roots while the borer targets leaves
(C) Both pests share identical feeding habits but occupy different altitudes
(D) The tea mosquito bug is holometabolous while the stem borer is not

2025

44. Which statement correctly identifies the feeding damage of the tea mosquito bug (Helopeltis antonii) on cashew crops?
(A) It feeds internally on the cashew kernel, leaving the apple intact
(B) It acts primarily as a root feeder, destroying tree nutrient uptake
(C) It causes die-back of shoots and scabs on floral branches and fruit
(D) It mines the mature leaves, forming distinct transparent blotches

2002

45. Consider the following statements regarding tree spice pests:
I. The cardamom shoot borer causes central shoot drying known as 'dead heart'.
II. The black pepper pollu beetle larva feeds primarily on the root system.
III. Scale insects on tree spices are typically managed using systemic insecticides.
IV. The pollu beetle adults are highly active flying insects that migrate extensively during winter.
Which of the above statement(s) is/are correct?
(A) I and III
(B) II and IV
(C) I, II and IV
(D) II, III and IV

2019

46. Based on its bionomics, which inference accurately explains the high severity of ginger shoot borer (Conogethes punctiferalis) damage during the monsoon season?
(A) The continuous rain physically washes away the natural predators of the borer
(B) The monsoon triggers a genetic mutation that enhances larval feeding capacity
(C) The insect synchronizes its larval phase with high humidity and growth
(D) The adults exclusively require flooded soil to successfully pupate

2023

47. Which pest is renowned for attacking the unopened flower buds of jasmine, weaving them together, and feeding entirely inside the bud?
(A) Chrysanthemum aphid
(B) Jasmine bud worm (Hendecasis duplifascialis)
(C) Rose chafer beetle
(D) Serpentine leaf miner

2023

48. Which environmental condition can be effectively manipulated to eliminate or reduce the incidence of greenhouse whiteflies in protected cultivation?
(A) Decreasing the structural integrity of the greenhouse glass
(B) Utilizing continuous 24-hour supplemental ultraviolet lighting
(C) Flooding the greenhouse floors completely with saline water
(D) Modifying temperature regimes and ensuring proper screening of vents

NODIA

2013

85. Consider the following statements regarding the safe use of acaricides in fresh vegetables:

I. Acaricides specifically target mites and generally have low toxicity to standard insect pests.

II. Pre-harvest intervals must be strictly observed to avoid toxic residues in fresh produce.

III. Mites frequently develop resistance to acaricides due to their short life cycles and high fecundity.

IV. Botanical acaricides like neem formulations never leave detectable residues.

V. Proper rotation of acaricides with different modes of action mitigates resistance.

Which of the above statement(s) is/are correct?

(A) I, II, III and V
(B) II, III, IV and V
(C) I, III, IV and V
(D) I, II, IV and V

2001

86. Which leguminous vegetable pest is characterized by laying single eggs on the calyx of flower buds, resulting in larvae that bore entirely inside the pod to consume the developing seeds?

(A) Bean aphid
(B) Pea stem fly
(C) Gram pod borer (Helicoverpa armigera)
(D) White grub

2018

87. The occurrence of "sooty mold" on mango leaves is predominantly an indirect consequence of heavy infestations by:

(A) Mango stem borer
(B) Mango nut weevil
(C) Mango fruit fly
(D) Mango hoppers and mealybugs

2005

88. The citrus blackfly (Aleurocanthus woglumi) typically deposits its eggs in which distinct pattern on the lower surface of the leaf?

(A) In a highly characteristic spiral path
(B) Singly along the main midrib
(C) In large disorganized masses covered with scales
(D) Deeply inserted into the spongy mesophyll layer

2010

89. Which management practice is universally recommended to control the spread of papaya mealybug?

(A) Frequent application of broad-spectrum organophosphates to clear all insects
(B) Conservation and inoculative release of specialized encyrtid parasitoids
(C) Complete defoliation of the papaya canopy during flowering
(D) Heavy application of soil-incorporated nematicides

2023

90. Which of the following represents the correct sequence of integrated management actions for controlling the codling moth in apples?

(A) Chemical spray → Pheromone mating disruption → Trunk banding → Harvesting
(B) Sanitation of dropped fruits → Pheromone monitoring → Targeted larvicidal spray → Trunk banding
(C) Trunk banding → Harvesting → Sanitation → Pheromone monitoring
(D) Targeted larvicidal spray → Sanitation → Chemical spray → Harvesting

2006

91. The primary damage symptom caused by grape thrips (Rhipiphorothrips cruentatus) is:

(A) Scab formation on berries leading to qualitative loss
(B) Sudden wilting of the main vine structure
(C) Large necrotic holes on the mature leaves
(D) Complete destruction of the root nodules

2009

92. The rhinoceros beetle causes distinct V-shaped geometric cuts on coconut fronds because:

(A) It feeds selectively only on the mid-veins of mature leaves
(B) The larvae mine the leaves in a zigzag pattern
(C) The adult beetle chews through tightly folded leaflets of the unopened spindle
(D) A secondary fungal pathogen follows its feeding path

2017

93. Which morphological symptom strongly indicates a severe attack of the white stem borer (Xylotrechus quadripes) in a coffee plantation?

(A) Complete defoliation leaving a sticky honeydew residue
(B) Water-soaked transparent lesions on the coffee berries
(C) Severe root knotting and immediate plant collapse
(D) Yellowing of leaves and ridges or rings on the

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2023

111. The pea pod borer (Etiella zinckenella) typically pupates in which location?
(A) Inside the mature pea pod
(B) Within the soil debris
(C) Exposed on the upper leaf surface
(D) Inside the central stem

2013

112. The prominent visual symptom of an advanced infestation by the mango stem borer (Batocera rufomaculata) is:
(A) Rapid skeletonization of the entire foliar canopy
(B) Immediate premature fruit drop during the marble stage
(C) The formation of massive galls on the terminal inflorescence
(D) Extrusion of sap and frass from holes in the main trunk

2019

113. The citrus fruit sucking moth (Eudocima spp.) is unique among Lepidopteran pests because its damage is caused primarily by the:
(A) Adult piercing the tough rind with a modified proboscis
(B) Actively feeding larval stage mining the fruit pulp
(C) Pupa secreting phytotoxic enzymes into the tree bark
(D) Freshly hatched caterpillars chewing the tender leaf flush

2014

114. Which specific agricultural practice most effectively prevents the carryover of banana rhizome weevil populations to a newly planted crop?
(A) Using heavy foliar sprays of fungicides
(B) Planting the suckers at extremely shallow depths
(C) Selection and paring of pest-free suckers before planting
(D) Defoliating the mother plant entirely before sucker separation

2002

115. Arrange the events in the life cycle of the woolly apple aphid (Eriosoma lanigerum):
I. Development of conspicuous white cottony masses on branches
II. Nymphal overwintering on the roots of the apple tree
III. Upward migration of nymphs to aerial parts during spring
IV. Downward migration to the root zone before severe winter
(A) I, III, II, IV
(B) II, III, I, IV
(C) II, I, III, IV
(D) III, I, IV, II

2009

116. The most characteristic external damage symptom of the pomegranate butterfly on developing fruits is:
(A) A distinctly hollowed-out rind with no internal damage
(B) Silvery, corky patches appearing strictly on the calyx
(C) Extensive webbing covering the entire fruit cluster
(D) Offensive odor from an exit hole plugged with excreta

2015

117. Which life stage of the red palm weevil is directly responsible for the extensive internal structural destruction of the coconut trunk?
(A) The adult flying weevil
(B) The stout, legless grub
(C) The egg
(D) The pupa inside its fibrous cocoon

NODIA

2008

118. In the management of tea mosquito bug on tea, plucking rounds are frequently adjusted. Why is hard plucking recommended during heavy infestations?
(A) To stimulate rapid root growth
(B) To enhance the chemical composition of the mature leaves
(C) To remove eggs in the tender flush and reduce breeding
(D) To reduce canopy shading and promote weed growth

2021

119. What makes the chemical management of the cashew stem and root borer relatively ineffective once symptoms become severe?
(A) The chemicals are completely neutralized by the acidic cashew sap
(B) The grub instantly pupates upon sensing any chemical application
(C) The pest rapidly volatilizes the chemical residues
(D) Hidden galleries physically isolate the grub from insecticide

2019

103. In insect biology, the term "bionomics" encompasses the study of:
(A) The genetic sequencing of pest genomes
(B) The mode of action of synthetic chemical pesticides
(C) The strict taxonomy and nomenclature of insects
(D) The relationship between biology, life cycle, and environment

2009

104. Which evolutionary adaptation significantly enhances the host range adaptability of polyphagous pests like the cotton bollworm (Helicoverpa armigera)?
(A) An array of mixed-function oxidase (MFO) digestive enzymes
(B) Highly specialized visual receptors for a single plant color
(C) Winglessness to conserve metabolic energy
(D) A purely symbiotic relationship with a specific soil fungus

2025

105. Each of the following questions consists of two statements, an Assertion (A) and a Reason (R). Select the correct answer using the codes given below:
Assertion (A): The whitefly (Bemisia tabaci) is a far more efficient vector of plant viruses compared to chewing insects.
Reason (R): Whiteflies inject saliva directly into the phloem during feeding, which facilitates the systemic spread of viral particles without instantly destroying the host cells.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2007

106. The use of sterile insect technique (SIT) for managing fruit flies relies fundamentally on which process?
(A) Introducing aggressive predatory insects into the field
(B) Flooding populations with sterile males to induce infertile matings
(C) Spraying chemical sterilants directly onto the crop canopy
(D) Genetically modifying the host plant to produce sterile pollen

2023

107. Which life stage of the hadda beetle (Henosepilachna vigintioctopunctata) is primarily responsible for the characteristic skeletonization of solanaceous leaves?
(A) Both the grubs and the adult beetles
(B) Only the adult beetles
(C) Only the final instar grubs
(D) The pupal stage

2002

108. What makes the management of the diamondback moth exceptionally difficult globally?
(A) Its ability to diapause for over a decade in the soil
(B) Its strictly nocturnal feeding habits that avoid all chemical sprays
(C) Widespread resistance to almost all classes of insecticides
(D) Its eggs being laid deep inside the crucifer stems

2011

109. Why are attractant traps using methyl eugenol highly effective specifically for the management of the oriental fruit fly (Bactrocera dorsalis)?
(A) Methyl eugenol is a potent sex pheromone released by the female fly
(B) It provides an essential nutrient that the larvae require to pupate
(C) It acts as a visual stimulant mimicking ripe yellow fruits
(D) It is a parapheromone that strongly attracts mature male flies

2021

110. Match the malvaceous crop pests (List I) with their typical symptoms of damage (List II).
List I: (Pests)
P. Okra shoot and fruit borer
Q. Cotton jassid
R. Whitefly
S. Red cotton bug
List II: (Symptoms of Damage)
1. Upward curling and yellowing of leaf margins (hopperburn)
2. Transmission of Yellow Vein Mosaic Virus
3. Staining of lint/seeds and shedding of buds
4. Terminal shoot withering and holes in developing fruits
(A) P-4, Q-1, R-2, S-3
(B) P-1, Q-4, R-3, S-2
(C) P-3, Q-2, R-1, S-4
(D) P-2, Q-3, R-4, S-1

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main trunk

2007

94. Why is the management of the cashew stem and root borer exceptionally challenging?
(A) It has a highly specialized resistant cuticle
(B) The pest primarily attacks fields exclusively at night
(C) The damaging larval stage remains hidden within internal woody tissues
(D) It rapidly develops resistance to all known botanical extracts

2010

95. Each of the following questions consists of two statements, an Assertion (A) and a Reason (R). Select the correct answer using the codes given below:
Assertion (A): Understanding the bionomics of holometabolous pests is critical for determining the timing of targeted pesticide application.
Reason (R): Different life stages (larva, pupa, adult) of holometabolous pests often occupy different niches and exhibit vastly varying susceptibilities to chemicals.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2009

96. Based on bionomics, which practice most effectively breaks the life cycle of the ginger shoot borer?
(A) Retaining the infested pseudostems as mulch in the field
(B) Continuous application of foliar fertilizers
(C) Growing ginger continuously on the same plot for multiple years
(D) Removal and destruction of dead hearts and infested plant debris

2017

97. The chrysanthemum aphid (Macrosiphoniella sanborni) causes direct economic loss by:
(A) Sucking sap from tender shoots causing flower buds to fail to open
(B) Boring into the woody stem
(C) Chewing the root hairs
(D) Mining the mature leaves leaving transparent trails

2011

98. Which of the following is NOT a common characteristic of leaf miner damage in greenhouse ornamentals?
(A) Visible serpentine trails on the foliage
(B) Reduction in aesthetic value of the plant
(C) Large jagged holes appearing in the center of the leaves
(D) Potential premature leaf drop in severe cases

2005

99. The two-spotted spider mite (Tetranychus urticae) typically infests which part of the plant, causing chlorotic stippling?
(A) The abaxial (lower) surface of the leaves
(B) The upper surface of the leaves
(C) The interior vascular bundles of the stem
(D) The underground fibrous roots

2003

100. Match the horticultural crop pests (List I) with the crop they predominantly infest (List II).
List I: (Pests)
P. Epilachna beetle
Q. Diamondback moth
R. Red pumpkin beetle
S. Spotted bollworm
List II: (Crops)
1. Cucurbits
2. Okra
3. Brinjal
4. Cabbage
(A) P-4, Q-3, R-1, S-2
(B) P-3, Q-4, R-1, S-2
(C) P-2, Q-1, R-4, S-3
(D) P-3, Q-1, R-4, S-2

NODIA

2021

101. Which parameter dictates the theoretical point at which pest control costs equal the economic loss caused by the pest?
(A) Economic Threshold Level
(B) Economic Injury Level
(C) General Equilibrium Position
(D) Damage Boundary

2007

102. The presence of multiple, tiny, circular exit holes on a mature tree trunk accompanied by frass is indicative of feeding by pests possessing which mouthparts?
(A) Siphoning
(B) Piercing and sucking
(C) Chewing and biting
(D) Sponging

2013

120. Pollu disease in black pepper, characterized by hollow berries, is primarily induced by the larval feeding of the pollu beetle. The term 'pollu' literally translates to:
(A) Hollow
(B) Rotten
(C) Webbed
(D) Blackened

2021

121. The aphid species most damaging to seed spices such as cumin and coriander causes yield loss by extracting sap from the:
(A) Root hairs
(B) Tender umbels and developing seeds
(C) Mature woody stems
(D) Hypocoytls of emerging seedlings

2002

122. Which pest is widely recognized for stripping the foliage and tender buds of jasmine, leaving only bare twigs, particularly during the monsoon season?
(A) Jasmine leaf webber
(B) Jasmine bud worm
(C) Serpentine leaf miner
(D) Red spider mite

2011

123. The widespread adoption of colored sticky traps (especially yellow) in greenhouses is predicated on the innate phototactic response of which primary pest?
(A) Cutworms
(B) Mealybugs
(C) Whiteflies
(D) Root-knot nematodes

2010

124. Broad mites (Polyphagotarsonemus latus) differ from traditional spider mites in that they:
(A) Are significantly larger and clearly visible to the naked eye
(B) Only infest root systems of horticultural crops
(C) Require a specific bacterial vector to complete their lifecycle
(D) Prefer apical foliage and rarely produce extensive webbing

2005

125. The pre-harvest interval (PHI) for a chemical applied to an edible horticultural crop fundamentally depends on its:
(A) Immediate knock-down effect on the pest
(B) Solvency in completely pure water
(C) Degradation rate and maximum residue limit (MRL)
(D) Cost per unit area applied

2024

126. A pest management strategy relies on keeping the pest population just below the Economic Injury Level rather than aiming for complete eradication. This strategy exemplifies:
(A) Eradicative control
(B) Integrated Pest Management (IPM)
(C) Preventive control
(D) Quarantine operations

2015

127. The evolutionary adaptation of "mining" mouthparts specifically enables an insect larva to:
(A) Ingest copious amounts of sap directly from the vascular bundle
(B) Chew entirely through the lignified tree bark
(C) Siphon nectar from extremely long floral tubes
(D) Consume mesophyll while protected by leaf epidermis

NODIA

2014

128. In hemimetabolous development, the morphological stage that physically bridges the egg and the sexually mature adult is termed the:
(A) Nymph
(B) Maggot
(C) Caterpillar
(D) Pupa

2025

129. The concept of "host range adaptability" in phytophagous insects is heavily influenced by the insect's physiological capacity to:
(A) Survive completely without water for extended periods
(B) Alter its wing shape depending on the host plant structure
(C) Detoxify secondary metabolites found in different plants
(D) Complete its life cycle devoid of any nutritional intake

2024

130. Whiteflies typically transmit Begomoviruses in which specific transmission manner?
(A) Persistent-circulative
(B) Non-persistent
(C) Semi-persistent
(D) Mechanical contamination only

period of rapid vegetative growth and high humidity. These environmental conditions are optimal for the survival and activity of the larvae as they bore into the pseudostems. The increased availability of tender host tissue during the rainy season further supports the pest population.

47. (B) Jasmine bud worm (Hendecasis duplifascialis)
The jasmine bud worm is a specialized pest that targets the unopened flower buds. The larvae weave the buds together with silken threads and feed internally, consuming the reproductive parts. This feeding prevents the flowers from blooming, leading to significant economic losses. The presence of silk-webbed buds and exit holes is a clear indicator of this pest's presence during the peak flowering season.

48. (D) Modifying temperature regimes and ensuring proper screening of vents
Managing greenhouse whiteflies involves a combination of physical and environmental controls. Modifying the temperature regimes can slow down the pest's reproduction rate, while ensuring that all vents and openings are properly screened with fine mesh prevents the entry of adult flies from the outside. These practices, combined with proper ventilation to reduce humidity, create a less favorable environment for whitefly pest outbreaks.

49. (A) They cause damage strictly through chewing and biting plant tissues
Phytophagous mites do not possess chewing and biting mouthparts; instead, they have specialized needle-like chelicerae used to pierce plant cells and suck out the contents. They characteristically have three pairs of legs in the larval stage and often increase in population after the use of certain synthetic pyrethroids. False spider mites are also noted for their lack of extensive silken webbing.

50. (A) P-4, Q-1, R-3, S-2
The waiting period or PHI is the minimum time required between the last pesticide application and harvest to ensure safety. The Maximum Residue Limit is the highest concentration of a pesticide legally allowed on a crop. Acceptable Daily Intake represents the safe long-term exposure level for humans. Finally, the Lethal Dose is a measure used to determine the toxicity required for half mortality.

51. (A) EIL represents the threshold of economic loss, whereas GEP is the average long-term population density in the absence of control
The Economic Injury Level is the lowest pest population density that will cause economic damage, where the cost of control equals the value of the lost yield. In contrast, the General Equilibrium Position is the average population density of an insect over a long period in a particular environment without human intervention. While EIL is a management threshold, GEP describes natural status.

52. (D) Chewing and biting
The "shot-hole" symptom occurs when small, circular areas of leaf tissue are consumed or die and fall out, leaving holes reminiscent of a shotgun blast. This type of damage is typically caused by pests with chewing and biting mouthparts, such as certain beetles or young caterpillars. These insects physically remove portions of the leaf blade, and the injuries expand into characteristic holes.

53. (B) Juvenile Hormone
In holometabolous insects, the transition between life stages is controlled by the interaction of hormones. Ecdysone triggers molting, but the type of molt is determined by the titer of Juvenile Hormone. A high level of Juvenile Hormone ensures a larva-to-larva molt, while a significant decrease in levels allows the insect to pupate. Therefore, the drop in Juvenile Hormone initiates the pupal stage.

54. (C) High genetic plasticity and enzymatic detoxification mechanisms
A pest's ability to adapt to a wide range of host plants is significantly enhanced by its genetic plasticity and the presence of diverse enzymatic detoxification mechanisms. These physiological traits allow polyphagous insects to neutralize a variety of secondary plant metabolites and toxins produced by different host species. This flexibility enables them to exploit various horticultural ecosystems even when their primary host is unavailable.

55. (C) I, III and IV
The red pumpkin beetle is a known vector for bacterial wilt in cucurbits. The banana aphid transmits the Banana Bunchy Top Virus in a circulative, non-propagative manner, and leafhoppers are the primary vectors for various

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branches
(D) It forms sap-sucking crusts that inject lethal toxins

2003

141. Guava fruit flies primarily oviposit their eggs in which specific layer of the host fruit?
(A) The extreme outer waxy cuticle
(B) Directly into the central seed core
(C) Just beneath the rind into the maturing pulp
(D) Into the woody fruit petiole

2017

142. The black-headed caterpillar (Opisina arenosella) is a major pest of coconut. Its characteristic damage involves:
(A) Boring into the soft developing nuts
(B) Constructing silken galleries and feeding on green matter
(C) Tunneling into the main trunk causing sap exudation
(D) Chewing the fibrous roots leading to palm toppling

2017

143. Which management approach relies entirely on the principle of trap cropping to protect main crops from specific pests?
(A) Applying systemic chemical pesticides to all plants
(B) Using yellow sticky cards in greenhouses
(C) Deploying pheromone-baited water traps
(D) Cultivating marigolds to attract tomato fruit borer

2024

144. Which factor heavily contributes to the high economic damage caused by the tea mosquito bug on cashew?
(A) Toxic saliva causes rapid drying of shoots and immature nuts
(B) The bugs travel in massive migratory swarms across continents
(C) The pest completely consumes the mature foliage within days
(D) The eggs act as primary vectors for lethal cashew bacterial wilt

2022

145. Cardamom thrips predominantly establish their colonies in which microhabitat of the plant?
(A) Deep inside the subterranean rhizome
(B) On the fully exposed upper surface of mature leaves
(C) Within the concealed leaf sheaths and floral bracts
(D) Exclusively inside the fully ripened, dried capsules

NODIA

2016

146. A critical symptom indicating ginger shoot borer infestation is:
(A) Frass extrusion and yellowing of the central shoot
(B) Silvery patches on the underground rhizome
(C) Rapid defoliation of the lower leaves without stem damage
(D) Complete rotting of the seed pieces before germination

2008

147. Which pest commonly affects open-field roses by feeding aggressively on the leaf margins, often leaving a distinct serrated or semi-circular appearance?
(A) Rose thrips
(B) Rose aphid
(C) Rose scale
(D) Rose leaf-cutting bee

2003

148. Serpentine leaf miners (Liriomyza spp.) in ornamental plants are notoriously difficult to control chemically because:
(A) They possess exceptionally thick, chitinous cuticles
(B) Feeding stages are protected between epidermal layers
(C) They actively excrete all ingested toxins
(D) They migrate out of the greenhouse immediately upon spraying

2019

149. The widespread application of broad-spectrum synthetic pyrethroids in horticultural crops frequently leads to secondary outbreaks of which pest group?
(A) Lepidopteran stem borers
(B) White grubs
(C) Phytophagous mites
(D) Fruit flies

2001

150. Good Agricultural Practices (GAP) dictate that farmers must strictly adhere to the recommended Pre-Harvest Interval (PHI). If a farmer violates the PHI, the most immediate consequence is:
(A) Sudden phytotoxicity and burning of the crop foliage
(B) Enhanced resistance development in the target pest

28. (C) Pupa
Incomplete metamorphosis, or hemimetabolous development, is characterized by three distinct life stages: egg, nymph, and adult. This developmental pathway does not include a pupal stage, which is only found in holometabolous insects undergoing complete metamorphosis. Therefore, targeting the pupal stage as a control strategy is impossible for pests such as aphids, leafhoppers, or grasshoppers that exhibit this type of development cycle.

29. (D) It is a highly restricted specialist feeding only on a single plant family
The diamondback moth is a cosmopolitan pest with a wide distribution facilitated by the global movement of cruciferous seedlings. While it is a specialist that primarily feeds on plants containing glucosinolates, it is not restricted to a single plant family. It can attack a variety of wild and cultivated brassicas and even some non-brassicaceous plants, making it a highly adaptable pest.

30. (B) Acquisition → Latent Period → Retention → Inoculation
The process of persistent virus transmission by aphids involves four distinct phases. First, the vector acquires the virus while feeding on an infected plant. Following acquisition, there is a latent period during which the virus moves through the vector's body to the salivary glands. The virus is then retained within the vector for an extended period, allowing for subsequent inoculation into healthy hosts.

31. (B) Biological control
Encarsia formosa is a tiny parasitic wasp used extensively in greenhouses to manage whitefly populations. This strategy is a form of biological control, as it utilizes a natural enemy to regulate the pest population. The wasp lays its eggs inside the whitefly nymphs, eventually killing them. This method is highly effective in protected environments and reduces the reliance on synthetic chemical insecticides.

32. (D) The use of the species-specific female sex pheromone blend
Mass trapping of the brinjal shoot and fruit borer is successfully achieved using traps baited with the species-specific female sex pheromone blend. This chemical attractant selectively lures adult males, disrupting the mating cycle and reducing the overall population density in the field. This environmentally friendly approach is a core component of Integrated Pest Management, as it specifically targets the target pest species.

33. (A) Mustard sawfly - Overwinters as a pupa in a cocoon in the soil
The mustard sawfly is a significant pest of cruciferous crops. Its life cycle involves an overwintering period during which it remains as a pupa within a silken cocoon in the soil. This strategy allows the insect to survive unfavorable winter conditions and emerge as an adult when the next season begins. Understanding this soil-dwelling stage is important for implementing cultural control measures.

34. (C) Seedling and early vegetative stages
The red pumpkin beetle is most destructive during the seedling and early vegetative stages of cucurbitaceous crops. The adult beetles feed aggressively on the cotyledons and young leaves, often leading to the death of the seedlings if the infestation is severe. Although they can feed on flowers and fruits later in the season, the economic loss is most critical initially.

35. (A) II and III
In malvaceous crops like okra, jassids cause hopperburn, which involves the yellowing and curling of leaf margins due to toxic saliva. Whiteflies are the essential vectors for the Yellow Vein Mosaic Virus, a major disease. However, the okra fruit borer does not spare the fruits; it is notorious for boring into both terminal shoots and developing fruits, causing economic loss.

36. (D) Tender shoots, flower buds, and the developing pods
The leguminous pod borer, Maruca vitrata, is known for its characteristic behavior of spinning a protective web. This web primarily encloses the tender shoots, flower buds, and developing pods of the host plant. The larvae feed within this silken shelter, which protects them from predators and environmental factors. The presence of these webs containing frass is a key diagnostic feature in the field.

37. (B) It reduces non-target exposure and overall pesticide load in the orchard
Localized bait sprays for mango fruit fly management combine a food attractant with a toxicant, targeting only the adult flies. This

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ANSWERS

1. (A) The pest density at which control measures must be taken to prevent the population from reaching the Economic Injury Level
The Economic Threshold Level is the pest density at which control measures must be initiated to prevent the population from reaching the Economic Injury Level. It serves as a warning signal for farmers to intervene before economic losses occur. Monitoring this level ensures that pest management is cost-effective and reduces unnecessary chemical applications, maintaining ecological balance in horticultural crops.

2. (C) Rasping and sucking
Rasping and sucking mouthparts are characteristic of thrips, which use them to lacerate the epidermis of plant tissues. After scraping the surface, they suck the oozing sap. This damage typically results in silvery or whitish patches on leaves and fruits due to air entering the emptied cells. It is a major cause of quality deterioration in various horticultural crops.

3. (A) The presence of a pupal stage involving complete morphological reorganization
Holometabolous development, known as complete metamorphosis, involves four distinct life stages: egg, larva, pupa, and adult. The inclusion of a pupal stage allows for complete morphological and physiological reorganization. In contrast, hemimetabolous development lacks a pupal stage, with nymphs resembling adults. This distinction is critical for understanding the bionomics and habitat requirements of various horticultural insect pests during management.

4. (D) Mustard aphid
Mustard aphids are small, soft-bodied insects that rely heavily on wind currents for long-distance passive dispersal. Their lightweight bodies and occasionally winged forms allow them to be carried across large geographic regions by air movements. This mechanism facilitates the rapid spread of infestations and the transmission of viral diseases in horticultural landscapes, making early detection and monitoring extremely challenging for growers.

5. (B) I and III
Aphids are highly efficient vectors for numerous non-persistent plant viruses, which they transmit during brief probing of the host tissue. Thrips serve as the primary vectors for Tospoviruses, including the Peanut Bud Necrosis Virus. Whiteflies, however, are not the exclusive vectors of all Tospoviruses. Understanding these specific vector-pathogen relationships is essential for implementing targeted disease management strategies in commercial horticulture.

6. (C) Trap cropping
Trap cropping is a cultural control strategy where a more attractive host plant is grown near the main commercial crop. This sacrificial crop lures pests away, concentrating them in a small area for easier management or destruction. This technique significantly reduces the pest pressure on the primary crop and minimizes the overall need for chemical insecticide applications throughout the growing season.

7. (D) Scraping leaf tissue leaving a characteristic skeletonized network of veins
The Epilachna beetle, also known as the hadda beetle, damages solanaceous vegetables like brinjal. Both larvae and adults possess chewing mouthparts used to scrape the chlorophyll-rich leaf tissue from the surface. This feeding behavior results in a characteristic skeletonized appearance, where only a network of veins remains. Such extensive foliar damage significantly reduces the photosynthetic capacity and overall yield.

8. (A) In a loose silken cocoon attached to the lower surface of host leaves
The diamondback moth is a significant pest of cruciferous crops like cabbage and cauliflower. Upon completing its larval development, the caterpillar spins a loose, greyish, silken cocoon for pupation. These cocoons are typically found attached to the lower surface of the host leaves or on the stems. Understanding this microhabitat is vital for monitoring the pest and evaluating control measures.

NODIA

9. (B) Secondary infections entering through oviposition punctures and larval galleries
Melon fruit fly damage begins when the female punctures the fruit to deposit eggs. The subsequent larval feeding creates internal galleries, but the primary cause of rotting is secondary infection. Bacteria and fungi enter through the oviposition punctures and feeding tunnels, leading to rapid tissue decay and fruit drop. This indirect damage often causes greater economic loss than direct feeding.

10. (C) A is true but R is false.
The spotted bollworm is a major pest of okra, where larvae bore into terminal shoots and developing fruits, causing significant yield loss. However, these insects belong to the order Lepidoptera and possess chewing mouthparts in their larval stage, not piercing and sucking mouthparts. Therefore, the claim regarding sap-sucking behavior as the mechanism for extracting nutrients is biologically incorrect.

11. (A) Silvery-white blotches on leaves that eventually dry up and distort
Onion thrips use their rasping and sucking mouthparts to damage the foliage of bulb crops. Their feeding removes the cellular contents, allowing air to enter the empty spaces, which creates a characteristic silvery-white blotchy appearance on the leaves. As the infestation progresses, the affected leaves may become distorted, dry up, and eventually wither, leading to a substantial yield reduction.

12. (C) The adult female lays eggs exclusively on the bark of the main tree trunk
The mango nut weevil is a specialized pest where the grub feeds exclusively on the cotyledons inside the mango stone. Development occurs entirely within the fruit, and the adult eventually chews its way out. The female lays her eggs on the skin of young, developing fruits, not on the bark of the tree trunk, ensuring larvae can penetrate easily.

13. (D) Serpentine silvery galleries on the tender foliage of the citrus tree
The citrus leaf miner is a serious pest of citrus nurseries and young orchards. The tiny larvae mine between the epidermal layers of tender leaves, creating serpentine, silvery galleries. This feeding causes the leaves to curl, twist, and become distorted, which severely impairs the photosynthetic ability of the plant. In extreme cases, the affected foliage may dry up and fall off.

14. (C) It fails to prevent the spread of the virus once initial inoculation occurs
The banana aphid is the primary vector for the Banana Bunchy Top Virus. Relying solely on chemical insecticides is often ineffective because it fails to stop the transmission of the virus. Even a small number of aphids can inoculate the plant before the insecticide takes effect. Therefore, pest management must focus on preventing the initial introduction of the vector.

15. (A) I, II and IV
San Jose scale overwinters in the black cap stage, while the woolly apple aphid produces cottony colonies on branches and roots. The peach leaf curl aphid induces pseudo-galls on leaves. However, the codling moth is a fruit borer, not a leaf miner, as its larvae penetrate the fruit to feed on seeds. These biological facts are crucial for identification.

16. (D) The specific color of the mature grape berries
During the pruning season, grape flea beetle population dynamics are influenced by the availability of sprouting buds, which serve as their primary food source. Environmental conditions like temperature and humidity, along with the timing of pruning, also play critical roles in their activity and survival. However, the color of mature grape berries is irrelevant because the beetles are active earlier.

17. (A) Eriophyid mite - Boring deep tunnels into the primary roots of the palm
The coconut eriophyid mite is a specialized pest that feeds on the soft tissues under the perianth of young nuts, causing triangular white patches and surface cracking. It does not bore into the roots of the palm. In contrast, the rhinoceros beetle causes V-shaped cuts, the red palm weevil destroys the growing point, and the caterpillar defoliates the leaflets.

18. (C) Timely harvesting and removal of gleaned berries from the soil surface
The coffee berry borer is a destructive pest that completes its life cycle inside the coffee berry. An effective integrated management strategy involves sanitation through timely harvesting and the collection of fallen or gleaned berries

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from the ground. This practice removes the primary source of infestation and prevents the pest from surviving between seasons, thereby reducing the population for subsequent crops.

19. (A) The collar region of the trunk and the primary structural roots
The cashew stem and root borer is a cryptic pest whose larvae bore into the collar region of the trunk and the primary structural roots. This internal feeding disrupts the vascular system, leading to gum exudation, yellowing of the canopy, and eventual death of the tree. Because the damage occurs internally and often below the soil line, early detection is difficult.

20. (A) P-4, Q-2, R-3, S-1
Cardamom thrips cause characteristic scab formation and corky encrustations on the capsules, reducing their market value. The cardamom shoot borer larvae bore into the pseudostems, resulting in the death of the central growing point. Black pepper pollu beetle larvae feed on the internal contents of the berries, while the cinnamon butterfly is known for defoliating the tender foliage of host plants.

21. (B) Phloem sap extraction
The coriander aphid is a major pest that feeds by inserting its stylets into the plant's vascular system to extract phloem sap. This depletion of nutrients and water leads to severe stunting of the plant, curling of the leaves, and a significant reduction in seed yield. Additionally, the excretion of honeydew can promote the growth of sooty mold on the plants.

22. (C) The reproductive organs and delicate petals of open rose flowers
The rose chafer beetle is an important pest of commercial rose cultivation. The adult beetles are primarily attracted to the flowers, where they feed aggressively on the reproductive organs and the delicate petals. This direct destruction of the blossoms makes them unfit for sale, leading to significant economic losses for growers. Their activity is usually most intense during the peak flowering seasons.

23. (D) Injury to root hairs leading to wilting and reduced nutrient uptake
Fungus gnat larvae are common pests in greenhouse environments with high moisture. These larvae feed primarily on fungi but also attack the tender root hairs and roots of foliage ornamentals. This root damage results in wilting, poor nutrient uptake, and overall loss of plant vigor. Severe infestations can make plants more susceptible to soil-borne pathogens, further impacting their market value.

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24. (A) Trombidiformes
Phytophagous mites, such as spider mites and broad mites, belong to the order Trombidiformes within the class Arachnida. These organisms are distinct from insects and are major pests in many horticultural ecosystems. They typically possess four pairs of legs in the adult stage and lack antennae. Understanding their taxonomy is essential for selecting appropriate acaricides, as they respond differently than insects.

25. (A) I, III and V
The Pre-Harvest Interval is designed to ensure that pesticide residues degrade to levels below the Maximum Residue Limits before consumption. Organochlorine pesticides are notorious for their high environmental persistence compared to organophosphates. Additionally, adhering to Good Agricultural Practices is vital for minimizing residues. However, waiting periods vary by crop and climate, and botanicals often have short intervals, unlike the incorrect statements.

26. (B) Increase and eventually surpass the Economic Injury Level (EIL)
The Economic Threshold Level is defined as the pest density at which control measures should be initiated to prevent an increasing population from reaching the Economic Injury Level. If no intervention occurs once the ETL is reached, the pest population will likely continue its growth trajectory and eventually surpass the EIL, leading to economic damage that exceeds the cost of control measures.

27. (A) Their siphoning mouthparts are adapted to draw liquid nectar
Adult butterflies and moths possess siphoning mouthparts, which are highly specialized for consuming liquid food. These mouthparts consist of a long, coiled tube called a proboscis that can be extended to reach nectar deep within flowers. This modification allows them to act as pollinators while fulfilling their nutritional requirements. Unlike their larval stages, the adults do not cause physical plant tissue damage.

(C) Immediate legal confiscation of the farmland
(D) Residues likely exceeding the Maximum Residue Limit

2003

151. What specific concept dictates the baseline pest density at which management action must be decisively taken to avoid reaching the Economic Injury Level?
(A) Economic Threshold Level
(B) Aesthetic Injury Level
(C) Damage Boundary
(D) General Equilibrium Position

2019

152. Adult moths and butterflies that exclusively consume liquids like nectar possess mouthparts heavily modified into a tubular structure known as a:
(A) Stylet
(B) Proboscis
(C) Labium
(D) Mandible

2018

153. A horticultural pest that completes its life cycle passing through the stages of egg, multiple nymphal instars, and a winged adult without a pupal stage belongs to the group:
(A) Endopterygota
(B) Exopterygota
(C) Apterygota
(D) Holometabola

2005

154. What is the fundamental mechanism allowing mealybugs to disperse across wide geographic areas despite the females being largely apterous (wingless)?
(A) Passive transport via wind and infested planting material
(B) They swim efficiently through irrigation channels
(C) They attach themselves to migratory birds
(D) Females develop functional wings during the monsoon

2010

155. Which of the following viral diseases is actively transmitted by the melon aphid (Aphis gossypii) in cucurbitaceous crops?
(A) Tomato Leaf Curl Virus
(B) Papaya Ringspot Virus
(C) Cucumber Mosaic Virus
(D) Banana Bunchy Top Virus

2015

156. In Integrated Pest Management, the strategic use of crop rotation is primarily intended to:
(A) Increase the overall aesthetic value of the farm
(B) Eradicate all beneficial insect populations from the field
(C) Reduce the need for any water irrigation
(D) Break life cycles by removing obligate host plants

2005

157. The brinjal shoot and fruit borer is highly host-specific. It belongs to which insect order?
(A) Coleoptera
(B) Hemiptera
(C) Lepidoptera
(D) Diptera

2024

158. Which of the following statements about the cabbage butterfly is correct regarding its oviposition behavior?
(A) Eggs are laid singly on the stem near the soil line
(B) Eggs are laid in distinct clusters on the leaf underside
(C) Eggs are inserted directly into the primary leaf veins
(D) Eggs are broadcast randomly over the soil surface

2008

159. For effective control of cucurbit fruit flies, poison baits typically consist of an insecticide mixed with which highly attractive food source?
(A) Powdered sulfur
(B) Synthetic neem oil
(C) Fine clay dust
(D) High-protein yeast extract or molasses

2001

160. What is a key diagnostic field symptom of severe whitefly infestation in okra fields besides the transmission of viruses?
(A) Foliar blackening due to mold on honeydew excreta
(B) The presence of completely skeletonized leaves
(C) Large, circular chewing holes in the mature fruits
(D) Complete wilting and rotting of the central taproot

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method is superior to blanket chemical sprays because it significantly reduces the overall pesticide load in the orchard and minimizes exposure to non-target organisms, including beneficial insects and pollinators. This targeted approach is more sustainable and effectively reduces the pest population.

38. (C) Citrus butterfly - Using pheromones to disrupt the larval pupation
Management of the citrus butterfly usually involves hand-picking of larvae or the application of Bacillus thuringiensis and chemical insecticides. Pheromones are not commonly used to disrupt larval pupation for this specific pest. In contrast, citrus psylla is managed with systemic insecticides, fruit-sucking moths are deterred by poison baits and light, and the citrus leaf miner is controlled through the pruning of foliage.

39. (D) Acerophagus papayae
The papaya mealybug is an invasive pest that caused widespread damage until the introduction of Acerophagus papayae. This specialized encyrtid parasitoid is highly effective and has provided sustainable, long-term management of the mealybug across many regions. Unlike general predators, Acerophagus papayae precisely targets the mealybug population, illustrating the success of classical biological control programs in protecting high-value horticultural crops like papaya.

40. (C) A is true but R is false.
The codling moth is indeed a major constraint in commercial apple production worldwide. However, the reason provided is incorrect; the larvae do not merely cause superficial cosmetic blemishes. Instead, the caterpillars bore deep into the fruit to feed on the developing seeds. This internal feeding makes the fruit totally unmarketable and often leads to premature fruit drop, representing a severe economic threat.

41. (B) Fungal or bacterial invasion leading to fruit rot and dropping
Infestation by the pomegranate butterfly involves the larva boring into the fruit and feeding on the pulp and seeds. This activity creates exit holes and internal cavities that facilitate the entry of secondary pathogens, such as fungi and bacteria. These infections cause the fruit to rot, emit an offensive odor, and eventually drop from the tree. Consequently, secondary rot causes total harvest loss.

42. (B) It feeds on sap of tender spindle leaves causing necrotic patches
The spindle bug is a significant pest of arecanut. Both nymphs and adults feed on the sap of the tender, unopened spindle leaves. Their feeding activity causes the formation of linear, necrotic patches that turn brown or black. As the leaf expands, these damaged areas may split, leading to stunted growth. In severe cases, the entire spindle may wither, impacting overall health.

43. (A) The bug causes shoot lesions while the borer mines the woody stem
The tea mosquito bug and the white stem borer have very different feeding habits. The bug is a sap-sucker that causes necrotic lesions on tender shoots and berries by injecting toxic saliva. In contrast, the white stem borer is a beetle whose larvae mine into the woody tissue of the coffee stem, causing internal structural damage. Understanding these differences is essential for management.

44. (C) It causes die-back of shoots and scabs on floral branches and fruit
On cashew, the tea mosquito bug is particularly destructive during the flushing and flowering stages. It feeds on the tender shoots, inflorescences, and developing nuts by sucking sap. This feeding causes rapid drying or 'die-back' of the shoots and the formation of characteristic corky scabs on the floral branches and young fruits. Such damage can lead to total crop failure if unmanaged.

45. (A) I and III
In tree spices, the cardamom shoot borer is known for causing dead hearts in pseudostems. Scale insects are effectively managed using systemic insecticides that reach the pests through the plant's sap. However, the pollu beetle larva feeds on the berries, not the roots, and the adults are small beetles with limited migratory range. These distinctions are vital for accurate pest identification and control.

46. (C) The insect synchronizes its larval phase with high humidity and growth
The ginger shoot borer exhibits high severity during the monsoon season because the insect synchronizes its larval development with the

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2011

131. Mechanical exclusion in IPM can be highly effective in high-value horticulture. Which of the following is a classic example of mechanical exclusion?
(A) Using botanical extracts to deter feeding
(B) Introducing ladybird beetles into the canopy
(C) Adjusting the timing of crop planting
(D) Covering fruit clusters with protective bagging

2024

132. The primary identification feature of the Epilachna beetle that distinguishes it from beneficial predatory ladybird beetles is the presence of:
(A) Highly glossy, completely unspotted elytra
(B) Fine pubescence (tiny hairs) covering the spotted elytra
(C) Distinctly clubbed antennae and short legs
(D) A strictly predatory behavior toward aphids

2001

133. The mustard sawfly (Athalia lugens proxima) is an anomalous pest of crucifers because the damaging "larva-like" stage actually belongs to the order:
(A) Lepidoptera
(B) Coleoptera
(C) Hymenoptera
(D) Diptera

2018

134. Red pumpkin bug (Coridius janus) nymphs and adults cause damage by:
(A) Mining the cotyledons
(B) Boring deeply into the maturing pumpkin fruit
(C) Skeletonizing the lower canopy foliage completely
(D) Sap-sucking from tender leaves while injecting toxic saliva

2002

135. The primary consequence of severe jassid (Amrasca biguttula biguttula) infestation on okra is referred to as "hopperburn," which is physiologically caused by:
(A) Injection of salivary enzymes during sap-sucking
(B) Extensive defoliation by adult feeding
(C) The physical severance of the main taproot
(D) Mechanical weight of the population breaking shoots

NODIA

2006

136. Why is the management of the onion thrips highly dependent on the spray application technique?
(A) Thrips fly away rapidly upon hearing the spray machinery
(B) Thrips congregate in leaf axils where sprays fail to penetrate
(C) The thrips possess an impenetrable waterproof waxy layer
(D) The thrips reside entirely beneath the soil surface

2009

137. Which cultural practice is most vital in disrupting the lifecycle of the mango fruit fly (Bactrocera dorsalis) within an orchard?
(A) Pruning the top canopy of the mango tree extensively
(B) Collection and destruction of fallen and infested fruits
(C) Frequent irrigation to maintain high soil moisture
(D) Painting the lower trunk with Bordeaux mixture

2012

138. The citrus leaf miner reduces the photosynthetic efficiency of the plant by:
(A) Creating twisting galleries in foliage causing leaf distortion
(B) Defoliating all mature leaves
(C) Boring into the central trunk and cutting off water supply
(D) Inducing immediate, severe leaf abscission via chemical toxins

2023

139. Which of the following pests causes damage by lacerating the banana fruit skin, resulting in superficial brown blemishes that severely reduce export quality?
(A) Banana aphid
(B) Banana pseudostem weevil
(C) Banana flower thrips
(D) Banana leaf roller

2017

140. San Jose scale (Quadraspidiotus perniciosus) is exceptionally devastating to temperate fruit trees mainly because:
(A) It causes immediate root death upon first contact
(B) It transmits lethal viral complexes to the apple fruits
(C) Its massive adult stage physically breaks the

phytoplasma diseases. However, Papaya ringspot virus is transmitted by aphids, and Citrus greening is transmitted by the citrus psylla, not the citrus butterfly, making statement V incorrect.

56. (A) Elevation of soil temperature using clear mulch to kill pests and pupae
Soil solarization is a hydrothermal process used to disinfect the soil. By covering moist soil with clear plastic mulch during periods of high solar radiation, the soil temperature is significantly elevated. This heat is sufficient to kill or weaken many soil-borne pests, including insect pupae, larvae, and eggs, as well as various pathogens. It is an effective, non-chemical physical control method for nurseries.

57. (B) Solanaceous crops
The hadda beetle, scientifically known as Henosepilachna vigintioctopunctata, is a major pest primarily associated with solanaceous crops. It is commonly found feeding on vegetables such as brinjal, potato, and tomato. Both the adult beetles and their spiny larvae consume the leaf tissue, leading to skeletonization. While they may occasionally feed on other plants, their primary economic impact is felt within the solanaceous group.

58. (B) Are gregarious in early instars and skeletonize leaves rapidly
Cabbage butterfly infestations are particularly devastating due to the feeding behavior of the larvae. The young caterpillars are highly gregarious and feed in large groups, which allows them to skeletonize the leaves of cruciferous plants very rapidly. As they grow and disperse, they can consume entire leaves, leaving only the thickest veins. This massive loss of foliage significantly reduces the yield and quality.

59. (A) Melon fruit fly
Covering developing bitter gourd fruits with protective paper bags is an effective physical control method against the melon fruit fly. The paper cover prevents female flies from laying eggs on young fruits, thereby reducing maggot infestation and fruit damage. This eco-friendly practice minimizes pesticide use and is commonly integrated with other pest management strategies for cucurbit crops.

60. (B) II, I, III, IV
The infestation of the brinjal shoot and fruit borer begins when the young larva enters the tender terminal shoot. This initial feeding causes the shoot to wilt and droop, a classic symptom known as “dead heart.” As the plant matures and fruits begin to develop, the larvae shift their focus and bore into the fruits. Finally, infested fruits undergo secondary rotting infections.

61. (D) Thrips
Thrips are the unique and primary vectors for the Tomato Spotted Wilt Virus, a pathogen that affects a wide range of horticultural crops including vegetables and ornamentals. The virus is acquired by the larvae and transmitted by the adults in a persistent-propagative manner. While aphids and whiteflies transmit many other viruses, they are not vectors for TSWV. Effective management requires strict vector control.

62. (C) Wingless adult female
The mango mealybug exhibits a distinct migratory behavior during its life cycle. After feeding on the tree canopy, the gravid, wingless adult females descend the trunk to the soil. They seek out cracks and crevices in the ground near the base of the tree to deposit their eggs inside protective ovisacs. This soil-dwelling phase is a critical point for intervention, such as trunk banding.

63. (B) Honeydew excretion serving as a substrate for Capnodium fungi
Sooty mold is a non-parasitic fungus that grows on the surface of leaves and fruits. It occurs following infestations by sap-sucking insects like the citrus blackfly, which excrete large amounts of honeydew. This sugary substance provides an ideal substrate for the growth of Capnodium species. While the mold itself does not infect the plant tissue, the thick black layer interferes with essential photosynthesis.

64. (D) Aggregates adults using host kairomones without environmental pollution
Pseudostem trapping is an effective mechanical control method for the banana weevil. The traps utilize pieces of cut banana pseudostem, which release host-specific kairomones that attract adult weevils. Once the adults aggregate under the traps, they can be manually collected and destroyed. This strategy is environmentally friendly as it reduces the need for chemical

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pumpkin beetles are primarily associated with the early growth stages of various cucurbit crops. Finally, the spotted bollworm is a notorious pest of okra, where its larvae bore into both terminal shoots and fruits.

101. (B) Economic Injury Level
The Economic Injury Level is a fundamental concept in Integrated Pest Management that defines the theoretical point where the cost of managing a pest equals the value of the potential yield loss. It represents the lowest population density of a pest that will cause economic damage. Maintaining pest populations below this level ensures that management actions are economically justified and biologically sound for farmers.

102. (C) Chewing and biting
The presence of circular exit holes on a tree trunk, accompanied by wood frass, is a clear indication of wood-boring insects. These insects possess strong chewing and biting mouthparts designed to tunnel through the lignified tissues of the plant. After completing their development inside the wood, adults use these same powerful mouthparts to chew their way out of the host tree trunk.

103. (D) The relationship between biology, life cycle, and environment
Bionomics is the branch of entomology that focuses on the comprehensive study of an organism's life history and its relationship with the environment. It encompasses various aspects, including the insect's life cycle stages, reproductive behavior, feeding habits, and its response to ecological factors such as temperature. Understanding the bionomics of a horticultural pest is essential for developing effective integrated management strategies.

104. (A) An array of mixed-function oxidase (MFO) digestive enzymes
Polyphagous pests like Helicoverpa armigera owe their wide host range to advanced physiological adaptations, particularly diverse mixed-function oxidase enzymes. These enzymes are responsible for the metabolic detoxification of various secondary plant metabolites, such as alkaloids, which are produced by different host plants as defense mechanisms. This enzymatic flexibility allows the pest to feed on hundreds of different plant species without being poisoned.

105. (A) Both A and R are true and R is the correct explanation of A.
Whiteflies are exceptionally efficient vectors because they utilize a specialized feeding strategy that facilitates virus transmission. By inserting their delicate stylets directly into the phloem tissue, they can acquire and inoculate viral particles without causing immediate mechanical damage or cell death to the host. This method allows the virus to spread systemically. In contrast, chewing insects cause massive tissue destruction, inhibiting transmission.

106. (B) Flooding populations with sterile males to induce infertile matings
The sterile insect technique is a highly specialized biological control method used for managing major pests like fruit flies. The process involves mass-rearing the target pest, sterilizing the males using radiation, and then releasing them in large numbers into the field. When these sterile males mate with wild females, no offspring are produced. Over time, repeated releases lead to a significant population decline.

NODIA

107. (A) Both the grubs and the adult beetles
In the case of the hadda beetle, both the larvae and the adult beetles are responsible for the characteristic damage seen on solanaceous crops. They possess chewing mouthparts and feed by scraping the chlorophyll-rich tissues from the leaf surface, typically leaving the veins and epidermis intact. This feeding behavior results in a skeletonized or lace-like appearance of the foliage, impacting the plant's health.

108. (C) Widespread resistance to almost all classes of insecticides
The diamondback moth is recognized as one of the most difficult pests to manage worldwide primarily due to its remarkable ability to develop resistance to insecticides. It was one of the first insects to show resistance to DDT and has since developed resistance to nearly every major class of synthetic chemicals. This widespread resistance, combined with its high reproductive rate, makes its control difficult.

109. (D) It is a parapheromone that strongly attracts mature male flies
Methyl eugenol is a powerful parapheromone that is highly attractive to the mature males of several fruit fly species, including the oriental fruit fly. When used in traps, it selectively lures

gnat larvae. While adults are mostly a nuisance, larvae can damage plant roots and transmit soil-borne pathogens. Implementing proper irrigation management is essential to prevent population increases.

74. (B) Lack of antennae and presence of four pairs of legs in the adult stage
Mites, belonging to the class Arachnida and order Acarina, differ fundamentally from insects in several morphological features. Adults typically possess four pairs of legs, whereas insects have only three pairs. Additionally, mites lack antennae and have a body that is generally not divided into a distinct head, thorax, and abdomen. These structural differences are important for identification and specialized chemical management.

75. (C) I, III and IV
Waiting periods are scientifically determined based on the degradation curve of a pesticide on a specific crop. Furthermore, repeated use of sublethal doses drives the development of insect resistance. Regulatory agencies enforce the Maximum Residue Limit to ensure consumer safety. However, the statement about contact insecticides requiring longer intervals than systemic ones is generally false, as systemic chemicals are more persistent.

76. (C) Market value of the crop and the proportionate damage caused per pest
To calculate the Economic Injury Level, several variables must be integrated into a mathematical model. These include the cost of the pest control measure, the market value of the crop, and the specific amount of damage caused by an individual pest. By analyzing these factors, growers can determine the precise pest density at which yield loss justifies the expenditure on control.

77. (D) Between the epidermal layers of the foliage
In entomology, the term "mining" refers to a specific feeding behavior where insect larvae live and feed between the upper and lower epidermal layers of a leaf. By consuming the nutrient-rich mesophyll tissue while remaining protected by the transparent epidermis, the larvae create visible trails. This internal feeding strategy protects them from many external predators and contact-based chemical pesticides during growth.

78. (C) Pupa
The pupa is a biologically quiescent but physiologically active stage found in holometabolous insects undergoing complete metamorphosis. During this phase, the insect does not feed and often remains immobile within a cocoon or puparium. The primary purpose of this stage is the radical transformation of the larval body into the adult form, which includes the development of wings and reproductive organs.

79. (B) A monophagous diet restricted to a rare, endemic plant
Rapid geographical dispersion of a pest is facilitated by traits such as high reproductive rates, strong flight capacity, or small size for wind dispersal. However, a monophagous diet restricted to a rare, endemic plant species acts as a significant barrier to dispersion. Without its specific host plant, the pest cannot survive or colonize new areas, regardless of its physical mobility capacity.

80. (A) P-4, Q-1, R-2, S-3
Aphids are the primary vectors for the Banana Bunchy Top Virus, which they transmit in a persistent manner. Thrips are specifically associated with the transmission of the Tomato Spotted Wilt Virus. Whiteflies are well-known vectors for the Papaya Leaf Curl Virus, while leafhoppers are the main insects responsible for spreading phytoplasma-induced diseases, such as the Little Leaf of Brinjal.

81. (A) Nocturnal phototropic adult insects
Light traps are a valuable tool in Integrated Pest Management for monitoring and suppressing populations of nocturnal insects. Many adult moths, beetles, and other pests are naturally attracted to certain wavelengths of light, a behavior known as positive phototaxis. By deploying these traps at night, growers can capture and identify active pests, helping to determine the need for further chemical control measures.

82. (C) Earthing up to prevent female access to tubers
Earthing up is a critical cultural practice for managing the potato tube moth. By maintaining a thick layer of soil over the developing tubers and ensuring that any soil cracks are filled, growers create a physical barrier that prevents

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pesticides and leverages natural behavior without causing pollution.

65. (A) I and III
The woolly apple aphid is notorious for causing gall-like swellings on both the aerial branches and the root system of apple trees. The peach leaf curl aphid overwinters as eggs on the host's bark, ensuring survival through the cold months. However, the San Jose scale is primarily ovoviviparous, meaning the eggs hatch within the female, making the statement about exclusive oviparity incorrect.

66. (C) The adults congregate to feed on newly emerging sprouting buds
Foliar sprays immediately after pruning are critical because the adult grape flea beetles emerge from hibernation during this time. They aggregate on the vines to feed specifically on the newly emerging and succulent sprouting buds. Since these buds represent the potential crop for the season, their destruction can lead to total yield loss. Targeting adults at this moment prevents bud damage effectively.

67. (A) Black-headed caterpillar - Application of systemic fungicides to the trunk
The black-headed caterpillar is an insect pest, and its management typically involves biological control or the application of insecticides. The use of systemic fungicides is incorrect because fungicides target fungal pathogens, not insect larvae. Other practices, such as using phorate for rhinoceros beetles, root feeding for red palm weevils, and botanical acaricides for eriophyid mites, are standard and recognized management techniques.

68. (D) Fungal infection of the insect cuticle and internal colonization
Beauveria bassiana is an entomopathogenic fungus used as a biological control agent against the coffee berry borer. The process begins when fungal spores come into contact with the insect's cuticle. The spores germinate and penetrate the exoskeleton using enzymes and mechanical pressure. Once inside, the fungus colonizes the internal tissues, leading to death. This natural process provides a sustainable alternative to chemical insecticides.

69. (B) Piercing tender flush and floral branches, resulting in blackened lesions
The tea mosquito bug causes severe damage to cashew plantations through its sap-sucking feeding habit. Both nymphs and adults pierce the tender flush, inflorescences, and young nuts, injecting toxic saliva in the process. This leads to the formation of characteristic blackened, necrotic lesions at the feeding sites. If the infestation is heavy, the affected shoots and floral branches dry up, reducing yield.

70. (A) Both A and R are true and R is the correct explanation of A.
Cardamom thrips are the most significant pest of cardamom capsules. They possess specialized rasping and sucking mouthparts used to lacerate the epidermal cells of the young, developing capsules. This feeding activity causes localized tissue death and leads to the formation of characteristic corky, scab-like encrustations on the surface. Since capsule appearance is a primary quality factor, this damage significantly reduces market value.

71. (D) Ginger and turmeric
The rhizome scale is a significant storage pest that specifically affects ginger and turmeric. These tiny, sap-sucking insects infest the rhizomes, forming a whitish or greyish encrustation on the surface. During storage, their feeding leads to the shriveling and dehydration of the rhizomes, which adversely affects their quality and viability as planting material. Effective management requires treating the seed rhizomes before storage.

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72. (A) Rose chafer beetle
The rose chafer beetle is a major pest of many open-field flowers, including roses and chrysanthemums. The adult beetles are primarily attracted to the reproductive parts of the plant and feed aggressively on the developing capitulum or floral head. By consuming the petals and essential floral organs, they render the flowers completely unmarketable. This direct destruction makes it a significant threat.

73. (B) Fungus gnats
Fungus gnats thrive in greenhouse environments characterized by high relative humidity, excessive soil moisture, and poor ventilation. These conditions promote the growth of fungi and algae, which serve as the primary food source for the

primarily qualitative, as the scarred berries are aesthetically unpleasing and unsuitable for table use or high-quality export markets.

92. (C) The adult beetle chews through tightly folded leaflets of the unopened spindle
The rhinoceros beetle causes characteristic V-shaped geometric cuts on coconut fronds because of the adult's feeding behavior. The beetle bores into the crown of the palm and chews through the tightly folded leaflets of the unopened spindle leaf. As the leaf eventually emerges and expands, the mechanical injuries inflicted by the beetle's mouthparts appear as symmetrical triangular notches along the frond margins.

93. (D) Yellowing of leaves and ridges or rings on the main trunk
A severe infestation by the white stem borer in coffee is characterized by distinct morphological changes in the host plant. The larvae bore into the woody stem, creating internal tunnels that disrupt the flow of nutrients and water. This results in the yellowing and wilting of the foliage. Externally, affected plants often show characteristic ridges or rings on the main trunk.

94. (C) The damaging larval stage remains hidden within internal woody tissues
Managing the cashew stem and root borer is exceptionally difficult because the damaging larval stage lives and feeds entirely within the internal woody tissues of the trunk and roots. This hidden lifestyle provides protection from most external factors, including contact insecticides. Because symptoms often appear only after significant internal damage has occurred, early detection is nearly impossible without invasive inspection of the tree.

95. (A) Both A and R are true and R is the correct explanation of A.
Understanding the bionomics of holometabolous pests is essential for effective management because their life cycle involves distinct stages that often occupy different ecological niches. Furthermore, these different stages exhibit vastly varying levels of susceptibility to chemical and biological control agents. By studying their biology, researchers can identify the most vulnerable stage in the life cycle and time their interventions for maximum efficacy.

96. (D) Removal and destruction of dead hearts and infested plant debris
Breaking the life cycle of the ginger shoot borer requires the removal of its primary habitat during the larval stage. Removing and destroying "dead hearts" where larvae are feeding prevents the insect from completing its development. Additionally, clearing infested plant debris from the field eliminates potential overwintering sites. These sanitation practices are more effective than continuous fertilizer or pesticide use in ginger.

97. (A) Sucking sap from tender shoots causing flower buds to fail to open
The chrysanthemum aphid causes significant economic loss in floriculture through its intensive sap-sucking activity. These aphids typically congregate on the tender terminal shoots and the base of flower buds. By extracting essential nutrients and water, they cause the shoots to become stunted and distorted. More importantly, their feeding can prevent the flower buds from opening properly, directly impacting commercial flower production quality.

98. (C) Large jagged holes appearing in the center of the leaves
Leaf miners are characterized by serpentine galleries they create between the epidermal layers of the foliage. This damage typically results in a reduction of the plant's aesthetic value and can lead to premature leaf drop. However, leaf miners do not create large jagged holes in the center of the leaves, as their larvae remain protected within the tissue and do not consume entire blades.

99. (A) The abaxial (lower) surface of the leaves
The two-spotted spider mite is a polyphagous pest that typically establishes its colonies on the abaxial surface of the leaves. From this protected location, they use their piercing-sucking mouthparts to feed on cells, resulting in chlorotic stippling on the upper surface. As the infestation grows, they produce fine silken webbing that can cover leaves and shoots, protecting the colony from various predators.

100. (B) P-3, Q-4, R-1, S-2
The Epilachna beetle is a major pest of brinjal, causing leaf skeletonization. The diamondback moth is the most significant pest of cabbage and other cruciferous vegetables worldwide. Red

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fallen and infested fruits. The larvae complete their development inside the ripening fruit and then emerge to pupate in the soil. By removing infested fruits from the ground, growers can significantly reduce the subsequent generation of flies.

138. (A) Creating twisting galleries in foliage causing leaf distortion
The citrus leaf miner reduces the photosynthetic efficiency of the host plant primarily through the mechanical damage caused by its larval feeding. By creating serpentine, silvery galleries within the tender leaves, the larvae destroy the chlorophyll-containing mesophyll cells. This internal mining causes the leaves to curl, twist, and become severely distorted, which reduces the total surface area available for essential light interception.

139. (C) Banana flower thrips
Banana flower thrips are specialized pests that cause significant qualitative damage to banana fruits. The adult thrips feed on the tender skin of the young, developing fingers while they are still enclosed within the floral bracts. Their mouthparts lacerate the surface cells, which later develop into characteristic reddish-brown, corky, or pimply blemishes as the fruit expands. This damage severely reduces the market value.

140. (D) It forms sap-sucking crusts that inject lethal toxins
San Jose scale is exceptionally devastating to temperate fruit trees because of its intensive feeding and toxic effects. These microscopic insects form dense, greyish crusts on the bark and fruits, where they suck large quantities of sap. During feeding, they inject a lethal toxin that causes reddish discoloration of the underlying tissue and eventually leads to the death of the affected branches.

141. (C) Just beneath the rind into the maturing pulp
Guava fruit flies exhibit a specialized oviposition behavior that ensures the survival and development of their offspring. The adult female uses her sharp ovipositor to puncture the skin of the ripening fruit and deposit her eggs just beneath the rind, directly into the maturing pulp. This provides the emerging larvae with immediate access to a rich food source for their subsequent development.

142. (B) Constructing silken galleries and feeding on green matter
The black-headed caterpillar is a serious defoliator of coconut palms. The larvae live on the underside of the leaflets, where they construct protective silken galleries or tunnels mixed with their own excreta. From within these galleries, they feed on the green chlorophyll-bearing matter of the leaflets, leaving only the thin upper epidermis intact. This loss of leaf area reduces the palm productivity.

143. (D) Cultivating marigolds to attract tomato fruit borer
Trap cropping is an ecologically based pest management strategy that involves planting a more attractive host species alongside the main crop to divert the pest population. A classic example is the cultivation of marigolds alongside tomato crops to manage the tomato fruit borer. The adult moths show a strong preference for laying their eggs on the marigold flowers rather than the tomato plants.

144. (A) Toxic saliva causes rapid drying of shoots and immature nuts
The high economic damage caused by the tea mosquito bug on cashew is primarily due to the potent toxic saliva it injects during feeding. When the bugs pierce the tender shoots to suck sap, the saliva causes a rapid and localized necrotic reaction. This leads to the quick blackening and drying up of the affected tissues, a condition known as "die-back."

145. (C) Within the concealed leaf sheaths and floral bracts
Cardamom thrips are highly specialized insects that prefer to establish their colonies in specific, protected microhabitats on the plant. They are typically found in the concealed spaces between the leaf sheaths and within the floral bracts of the panicles. These locations provide the thrips with a humid environment and protection from many predators, though it makes them difficult to control with foliar sprays.

146. (A) Frass extrusion and yellowing of the central shoot
A critical diagnostic symptom of ginger shoot borer infestation is the appearance of "dead hearts." This occurs when the larva bores into the pseudostem and feeds on internal tissues, causing the central growing shoot to turn yellow

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males from a large area, which is a technique known as male annihilation. By removing a significant portion of the male population, the chances of successful mating are greatly reduced.

110. (A) P-4, Q-1, R-2, S-3
In malvaceous crops, the okra shoot and fruit borer is identified by withered terminal shoots and holes in fruits. The cotton jassid causes "hopperburn," characterized by the upward curling and yellowing of leaf margins. Whiteflies are significant because they act as the primary vector for the Yellow Vein Mosaic Virus. Finally, the red cotton bug is known for staining the lint.

111. (B) Within the soil debris
The pea pod borer is a significant pest of various legumes. After the larva completes its development inside the pod, it emerges and drops to the ground. Pupation typically occurs within the soil or among the fallen leaves and debris on the field surface. The larva constructs a silken cocoon mixed with soil particles for protection during its transformation into an adult stage.

112. (D) Extrusion of sap and frass from holes in the main trunk
The mango stem borer is a large beetle whose larvae cause extensive internal damage to the tree. As the grubs tunnel through the woody tissue of the main trunk, they push out a mixture of chewed wood fibers and excreta, known as frass. The most prominent external sign of an advanced infestation is the extrusion of this frass and sap from holes.

113. (A) Adult piercing the tough rind with a modified proboscis
The citrus fruit sucking moth is unusual among Lepidoptera because the primary economic damage is caused by the adult stage rather than the larvae. The adults possess a highly modified, strong, and sharp proboscis that is capable of piercing the tough rind of ripening fruits. They then suck the internal juice, which leaves a puncture mark that serves as a rot entry.

114. (C) Selection and paring of pest-free suckers before planting
To prevent the carryover of banana rhizome weevil populations, the most effective cultural practice is the selection and preparation of pest-free suckers. This involves choosing healthy suckers from uninfested plantations and carefully paring away the outer layers of the rhizome to remove any eggs or young larvae. Treating the pared suckers ensures that the new plantation starts without the devastating pest infestation.

115. (B) II, III, I, IV
The annual life cycle of the woolly apple aphid involves seasonal migration between different parts of the host tree. During the winter, the nymphs typically overwinter on the roots for protection. In the spring, these nymphs migrate upward to the aerial branches and begin feeding, eventually forming cottony masses. Before severe winter, a portion of the population migrates downward back to the roots.

116. (D) Offensive odor from an exit hole plugged with excreta
A characteristic external symptom of the pomegranate butterfly is the presence of an exit hole on the fruit surface, which is often plugged with the excreta of the larva. This feeding activity inside the fruit leads to the development of an offensive odor and makes the fruit highly susceptible to secondary pathogens. While the larva feeds on internal seeds, the foul smell is reliable.

117. (B) The stout, legless grub
The red palm weevil is a highly destructive internal feeder of coconut palms. While the adult weevils are responsible for dispersal and laying eggs, the actual destruction is caused by the stout, legless grubs. Upon hatching, the larvae bore into the trunk, where they consume the soft vascular tissues and the apical growing point. This internal tunneling often leads to the palm's collapse.

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118. (C) To remove eggs in the tender flush and reduce breeding
In tea cultivation, adjusting the plucking rounds is a vital cultural control method for managing the tea mosquito bug. The adult bugs prefer to lay their eggs in the tender stalks of the young flush. By practicing "hard plucking," growers can physically remove the eggs and young nymphs from the field. This practice effectively breaks the pest's life cycle and reduces breeding.

119. (D) Hidden galleries physically isolate the grub from insecticide
Chemical management of the cashew stem and root borer is often unsuccessful once the

infestation is advanced because of the pest's internal feeding habit. The grubs create an extensive network of hidden galleries deep within the woody tissues of the trunk and roots. These tunnels are often filled with frass, which acts as a physical barrier, isolating the larvae from chemical reach.

120. (A) Hollow
The term 'pollu' is derived from a local language and literally translates to "hollow." This name describes the characteristic damage caused by the pollu beetle in black pepper. The larvae bore into developing green berries and feed on internal contents, leaving only the outer skin intact. As a result, the affected berries become light in weight, hollow, and turn black and shrivel.

121. (B) Tender umbels and developing seeds
Aphids are the most damaging pests for seed spices, particularly during the flowering stage. These insects congregate in large colonies on the tender umbels and the developing seeds. By using their piercing-sucking mouthparts to extract large amounts of sap, they deprive the seeds of the nutrients required for development. This leads to shriveling of the seeds, reduced weight, and significant yield loss.

122. (A) Jasmine leaf webber
The jasmine leaf webber is a common and destructive pest, especially during the humid monsoon season. The larvae are known for their characteristic behavior of webbing together several leaves and feeding on the chlorophyll inside the web. In cases of severe infestation, the caterpillars can be highly aggressive, stripping the foliage and tender buds from the entire plant, leading to total flower loss.

123. (C) Whiteflies
The use of yellow sticky traps in greenhouse environments is based on the innate behavioral response of several small flying pests, particularly whiteflies. These insects exhibit positive phototaxis and are highly attracted to the specific wavelength of light reflected by the yellow color. Once they fly towards the trap, they become permanently stuck to the adhesive surface, allowing for effective population monitoring.

124. (D) Prefer apical foliage and rarely produce extensive webbing
Broad mites differ significantly from spider mites in their biology and damage. Unlike spider mites, which often produce extensive silken webbing and can be found on mature leaves, broad mites are microscopic and specifically prefer to infest the apical foliage and terminal buds. Their feeding leads to the characteristic curling and hardening of the youngest leaves, often without any visible webbing on the foliage.

125. (C) Degradation rate and maximum residue limit (MRL)
The pre-harvest interval for a pesticide is determined by two main factors: the chemical's degradation rate on the crop and the established Maximum Residue Limit. The goal is to ensure that by harvest, any remaining residues have fallen to a level that is legally and scientifically considered safe for human consumption. Strictly following the PHI is essential for ensuring that produce meets safety standards.

126. (B) Integrated Pest Management (IPM)
Integrated Pest Management is a sustainable approach that focuses on long-term prevention and suppression rather than complete eradication. The primary goal is to maintain pest populations below the Economic Injury Level using a combination of cultural, biological, and chemical tools. By tolerating low levels of pests that do not cause significant economic loss, IPM programs preserve natural enemies and reduce environmental pollution.

127. (D) Consume mesophyll while protected by leaf epidermis
The adaptation for "mining" is specifically seen in certain insect larvae that feed internally within the leaf tissue. Their mouthparts are modified to consume the nutrient-rich mesophyll cells while the larvae remain safely sandwiched between the transparent upper and lower epidermal layers. This unique feeding strategy provides protection from many environmental stresses, such as dehydration, and shields them from many contact-based chemical pesticides.

128. (A) Nymph
In hemimetabolous development, the life cycle consists of three stages: egg, nymph, and adult. The nymph is the immature stage that physically bridges the egg and the sexually mature adult.

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Nymphs typically resemble the adults in body form and feeding habits but are smaller and lack functional wings. As they grow, they pass through successive molts, with each instar gradually developing adult features.

129. (C) Detoxify secondary metabolites found in different plants
The host range adaptability of phytophagous insects is fundamentally linked to their physiological ability to neutralize the defensive chemicals produced by plants. Adaptable pests possess complex enzymatic systems, like cytochrome P450 monooxygenases, that can detoxify these diverse compounds. This metabolic flexibility allows them to feed on a wide array of host plants across different horticultural ecosystems, making them highly adaptable generalists in nature.

130. (A) Persistent-circulative
Whiteflies transmit Begomoviruses in a persistent-circulative manner. This means that once the whitefly acquires the virus from an infected plant, the viral particles must pass through the insect's gut wall and reach the salivary glands before they can be inoculated into a new host. This process involves a latent period during which the vector is not yet infectious, making these viruses very difficult.

131. (D) Covering fruit clusters with protective bagging
Mechanical exclusion is a pest management strategy that uses physical barriers to prevent insects from reaching and damaging the crop. A classic example in high-value horticulture is the practice of bagging individual fruit clusters with paper or cloth covers. This barrier prevents pests like fruit flies and borers from accessing the fruit for feeding. This method is particularly useful for producing pesticide-free produce.

132. (B) Fine pubescence (tiny hairs) covering the spotted elytra
Identifying the Epilachna beetle correctly is important because, unlike many other ladybird beetles that are beneficial predators, this genus is herbivorous. The primary identification feature that distinguishes the Epilachna beetle from its predatory relatives is the presence of fine, short pubescence covering the elytra, giving it a duller appearance. Predatory ladybirds usually have smooth, glossy elytra without any visible hairy covering or pubescence.

133. (C) Hymenoptera
The mustard sawfly is an interesting pest of cruciferous crops because its damaging immature stage closely resembles a Lepidopteran caterpillar but actually belongs to the order Hymenoptera. The larvae are dark green and can be distinguished from true caterpillars by the number of prolegs. Because they are the larvae of a sawfly, they have six or more pairs of prolegs without any crochets.

134. (D) Sap-sucking from tender leaves while injecting toxic saliva
The red pumpkin bug is a significant sap-sucking pest that affects various cucurbitaceous crops. Both the colorful nymphs and the adults cause damage by using their piercing-sucking mouthparts to extract sap from the tender leaves and stems. During feeding, they inject toxic saliva into the plant tissue, which causes surrounding cells to die. This results in the formation of yellow or brown spots.

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135. (A) Injection of salivary enzymes during sap-sucking
Hopperburn is a devastating physiological condition in okra caused by the feeding of jassids. As these insects suck the phloem sap, they inject toxic salivary enzymes into the plant's vascular system. These toxins disrupt the normal physiological processes and interfere with the movement of nutrients within the leaf. The resulting symptoms include the characteristic upward curling and yellowing of the leaf margins.

136. (B) Thrips congregate in leaf axils where sprays fail to penetrate
Managing onion thrips is highly dependent on the precision of the spray application technique because of the pest's specific behavior. Thrips are very small and tend to congregate in the tight, concealed spaces of the leaf axils and the inner folds of the onion foliage. Most standard foliar sprays fail to penetrate these protected areas, allowing the thrips to survive and breed.

137. (B) Collection and destruction of fallen and infested fruits
The most vital cultural practice for disrupting the life cycle of the mango fruit fly within an orchard is the systematic collection and destruction of all

adult female moths from reaching the tubers to lay eggs. This simple intervention significantly reduces the incidence of larval infestation both in field and storage.

83. (A) Sap-sucking from flowers and pods, leading to poor seed formation
The mustard aphid is a highly prolific pest that reduces crop yield through its intensive sap-sucking activity. These insects congregate in large numbers on the tender shoots, inflorescences, and developing pods. By extracting large quantities of nutrients and water from these vital reproductive tissues, they cause flowers to wither and pods to shrivel. This results in poor seed formation and yield loss.

84. (D) Adult males seeking mates
Cuelure-based parapheromone traps are specifically designed to attract and capture the adult males of several fruit fly species, such as the melon fruit fly. This strategy, known as male annihilation, reduces the number of males available for mating, thereby lowering the overall population growth in the next generation. These traps are a key component of integrated pest management for selective monitoring.

85. (A) I, II, III and V
Acaricides specifically target mites and often have minimal impact on most insect species. Due to the risk of residues, adhering to pre-harvest intervals is essential for consumer safety. Mites develop resistance quickly because of short life cycles, so rotating chemicals with different modes of action is critical. However, botanical acaricides can still leave residues, making that specific claim in statement IV incorrect.

86. (C) Gram pod borer (Helicoverpa armigera)
The gram pod borer is a highly polyphagous pest that causes significant damage to various leguminous vegetables. The female moth typically lays her eggs singly on the flower buds or young pods. Upon hatching, the larva first feeds on the foliage before boring its way inside. Once inside, the caterpillar consumes the developing seeds, often leaving its posterior end outside the entry hole.

87. (D) Mango hoppers and mealybugs
The occurrence of sooty mold on mango trees is an indirect consequence of infestations by honeydew-producing insects, most notably mango hoppers and mealybugs. These pests suck large quantities of sap and excrete the excess sugars as honeydew, which coats the leaves. This residue provides the substrate for the growth of dark-colored Capnodium fungi, which interferes with photosynthesis and reduces the fruit marketability.

88. (A) In a highly characteristic spiral path
The citrus blackfly exhibits a highly distinctive oviposition behavior that is useful for field identification. The adult female deposits her eggs in a characteristic spiral or concentric circle pattern on the underside of the host leaves. This unique arrangement is a key diagnostic feature that distinguishes the blackfly from other whitefly species. Monitoring for these spirals allows growers to detect early infestations.

89. (B) Conservation and inoculative release of specialized encyrtid parasitoids
The management of the papaya mealybug is most effectively achieved through biological control. The introduction and conservation of specialized encyrtid parasitoids, particularly Acerophagus papayae, has proven to be a highly successful and sustainable strategy worldwide. These natural enemies precisely target the mealybug, providing long-term suppression of the pest population without the negative environmental impacts associated with frequent chemical insecticide applications.

90. (B) Sanitation of dropped fruits → Pheromone monitoring → Targeted larvicidal spray → Trunk banding
An effective IPM program for codling moth begins with orchard sanitation, specifically the removal of fallen, infested fruits. This is followed by using pheromone traps to monitor adult activity and determine optimal timing. Targeted larvicidal sprays are then applied when the eggs hatch and before larvae enter the fruit. Finally, trunk banding can be used to trap caterpillars seeking pupation sites.

91. (A) Scab formation on berries leading to qualitative loss
Grape thrips are major pests that primarily damage the developing berries and tender foliage. They use their rasping and sucking mouthparts to lacerate the fruit skin, which results in the formation of characteristic brown, corky scabs as the berries grow. This damage is

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and eventually dry up. Another clear indicator is the presence of small entry holes on the stem, which are often accompanied by the extrusion of frass.

147. (D) Rose leaf-cutting bee
The rose leaf-cutting bee is a unique pest of open-field roses, known for its highly characteristic damage to the foliage. The female bee uses her sharp mandibles to cut out neat, semi-circular or circular pieces from the leaf margins. These leaf segments are used as building material to construct nests. While the damage is primarily aesthetic, high populations can reduce leaf vigor.

148. (B) Feeding stages are protected between epidermal layers
Serpentine leaf miners are notoriously difficult to manage with chemical pesticides because of their internal feeding habit. The larval stages live and feed entirely between the upper and lower epidermal layers of the leaf. This position provides them with a physical barrier that protects them from many contact-based insecticides. For effective control, growers must use systemic insecticides that can be absorbed by the plant.

149. (C) Phytophagous mites
The widespread application of broad-spectrum synthetic pyrethroids in horticultural crops often leads to secondary outbreaks of phytophagous mites. This phenomenon occurs because these insecticides are highly effective at killing the natural predators of mites, such as predatory beetles. Without these natural enemies to regulate their population, the surviving mites multiply rapidly. Some pyrethroids may even have a stimulatory effect on mite fecundity.

150. (D) Residues likely exceeding the Maximum Residue Limit
Good Agricultural Practices emphasize the importance of adhering to the recommended Pre-Harvest Interval for every pesticide application. If a farmer violates this interval by harvesting too early, the most immediate consequence is that pesticide residues on the produce are likely to exceed the legally permitted Maximum Residue Limit. This makes the produce unsafe for consumption and can lead to its rejection in markets.

151. (A) Economic Threshold Level
The Economic Threshold Level is a critical baseline in Integrated Pest Management that serves as a warning signal for growers. It is defined as the pest density at which control measures must be decisively initiated to prevent the increasing population from reaching the Economic Injury Level. By acting when the population is at the ETL, growers ensure the cost of intervention is justified.

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152. (B) Proboscis
Adult moths and butterflies are characterized by their unique siphoning mouthparts, which are highly specialized for the consumption of liquid food. The central component of these mouthparts is the proboscis, a long, tubular structure formed from the modification of the maxillae. When not in use, the proboscis is kept tightly coiled. During feeding, the insect uncoils and extends the tube into floral nectaries.

153. (B) Exopterygota
Pests that exhibit hemimetabolous development, such as aphids and grasshoppers, belong to the group known as Exopterygota. Their life cycle is characterized by three stages: egg, nymph, and adult. Unlike holometabolous insects, these pests do not pass through a pupal stage. Instead, the nymphs resemble the adults in their appearance and feeding habits, although they are smaller and lack any functional wings.

154. (A) Passive transport via wind and infested planting material
Mealybugs are capable of dispersing across wide geographic areas despite adult females being wingless and sedentary. The primary mechanism for their long-distance movement is passive transport. Tiny, highly mobile first-instar nymphs can be easily carried by wind currents. Additionally, the global trade of horticultural products facilitates their spread, as they are often accidentally moved on infested planting material and various fresh fruits.

155. (C) Cucumber Mosaic Virus
The melon aphid is a highly efficient and well-known vector for the Cucumber Mosaic Virus in various cucurbitaceous crops. The virus is transmitted in a non-persistent manner, meaning the aphid can acquire it in seconds during probes and transmit it immediately. This rapid transmission makes management difficult, as

(C) Corcyra cephalonica
(D) Ephestia kuehniella

2025

22. In the context of storage microflora, what defines the succession from field fungi to storage fungi?
(A) A shift from drought-resistant species to flood-resistant species over the storage period
(B) A change from fungi that strictly produce aflatoxins to those that only produce fumonisins
(C) A transition from high water activity fungi to those tolerating lower water activity
(D) The gradual replacement of obligate insect pathogens with saprophytic yeasts

2005

23. What direct physiological effect does the proliferation of Aspergillus species have on a stored grain bulk?
(A) It halts the respiration of the grain embryo, abruptly cooling the bulk
(B) It chemically fixes atmospheric nitrogen, increasing the protein content of the grain
(C) It synthesizes dense silken structures that exclude oxygen from the interstitial spaces
(D) It metabolizes carbohydrates to generate localized zones of intense heat and moisture

2015

24. Which statement correctly describes the toxicological significance of fumonisins in contaminated storage grains?
(A) They are potent neurotoxins responsible for causing equine leukoencephalomalacia in horses
(B) They act primarily as powerful hepatocarcinogens synergistically with Hepatitis B virus in humans
(C) They immediately induce acute grocer's itch upon dermal contact during grain handling
(D) They specifically target the avian respiratory system, causing widespread mortality in godown pigeons

2013

25. Consider the following statements regarding abiotic and biotic factors in grain deterioration:
I. Grain moisture is the single most critical abiotic factor regulating insect and fungal population dynamics.
II. Fungal respiration can artificially raise the local moisture content of a grain bulk.
III. High relative humidity prevents the reproduction of all primary internal feeders.
IV. Storage mites require exceptionally dry conditions to proliferate rapidly.
V. Temperature gradients within a silo drive moisture migration through convection currents.
Which of the above statements are correct?
(A) I, II and IV
(B) I, II, III and V
(C) I, II and V
(D) II, IV and V

2013

26. Which of the following fungal genera is least likely to thrive under the low moisture conditions typical of mature, dry stored grains (water activity below 0.70)?
(A) Aspergillus
(B) Fusarium
(C) Eurotium
(D) Wallemia

2009

27. The occupational health hazard known as "grocer's itch" is an allergic contact dermatitis primarily caused by exposure to which group of organisms?
(A) Bodies and cast skins of storage mites such as Tyrophagus putrescentiae
(B) Airborne spores of Penicillium verrucosum found in damp grain storage
(C) Exuviae and frass of secondary external insect feeders in the warehouse
(D) Uric acid crystals derived from avian droppings found on grain sacks

2021

28. How does the hoarding behavior of Bandicota bengalensis specifically exacerbate quantitative losses in rural grain storage?
(A) It consumes the entire stored stock on-site within a few days of entry
(B) It aggressively defends the storage structure to prevent human pest control
(C) It excavates burrow systems to transport large volumes of grain underground
(D) It secretes pheromones that attract primary internal feeders to the product

2013

29. Identify the INCORRECT statement regarding the structural damage and biological signs associated with rodent pests in storage godowns.
(A) Mus musculus exhibits a localized, erratic nibbling behavior, damaging more grain

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CHAPTER 13

Pests of Stored Products and Their Management

2021

1. Which of the following biochemical pathways is primarily responsible for the continuous production of heat and moisture in properly stored, uninfested cereal grains?
(A) Aerobic respiration of the living grain embryo
(B) Anaerobic fermentation of stored grain starches
(C) Enzymatic degradation by inherent grain lipases
(D) Oxidative rancidity of inherent grain lipids

2006

2. What is the fundamental distinction between free water and bound water within grain moisture dynamics?
(A) Free water exerts no vapor pressure, whereas bound water is highly evaporative within the bulk
(B) Free water is chemically bound to proteins, whereas bound water exists in intercellular spaces
(C) Free water supports microbial growth, while bound water is held by macromolecular forces
(D) Free water is determined by oven drying, whereas bound water is measured by electronic meters

2003

3. Which of the following statements INCORRECTLY describes the process of nutritional depletion in stored grains?
(A) Qualitative degradation is limited to cosmetic changes and does not alter protein solubility
(B) Insect feeding on the germ primarily reduces the lipid and vitamin content of the grain
(C) Fungal infection typically increases the free fatty acid content through lipase activity
(D) Prolonged storage at high temperatures accelerates the breakdown of complex carbohydrates

NODIA

2001

4. In the context of storage losses, the Count and Weigh method is most appropriately applied to estimate which of the following?
(A) Qualitative depletion of seed viability
(B) Quantitative weight loss due to internal insect feeding
(C) Biochemical degradation of essential amino acids
(D) Physical damage to the storage structure

2007

5. Consider the following statements regarding the basic physiology of stored grains:
I. Heat of respiration from grains alone can raise bulk temperatures above 60 degrees Celsius.
II. An increase in grain moisture content exponentially increases the rate of grain respiration.
III. Biochemical degradation during storage often leads to a measurable increase in fat acidity.
Which of the above statements are correct?
(A) I and II
(B) III only
(C) II and III
(D) I only

2018

6. Which of the following best explains why isolated pockets of high moisture develop in a grain bulk despite uniform initial drying?
(A) Fungi rapidly consume free water, creating a vacuum that draws in moisture from the environment
(B) Internal insect feeders physically carry water droplets from the bottom of the silo to the top
(C) Convection currents drive warm, moist air which then condenses in the cooler regions of the bulk
(D) The phenomenon of hysteresis permanently prevents the grain from maintaining a

chemical control often fails to prevent the initial spread of the virus disease.

156. (D) Break life cycles by removing obligate host plants
In an Integrated Pest Management program, crop rotation is a fundamental cultural control practice used to disrupt the life cycle of specialized pests. By strategically changing the crop grown in a field, farmers remove host plants that certain pests need to reproduce. This is particularly effective against soil-borne pests with a narrow host range. Without suitable hosts, the population naturally declines.

157. (C) Lepidoptera
The brinjal shoot and fruit borer, scientifically known as Leucinodes orbonalis, is one of the most significant and host-specific pests of eggplant. It belongs to the order Lepidoptera, which includes all moths and butterflies. The damaging stage is the larva, a pinkish caterpillar that bores into terminal shoots and developing fruits. As a crambid moth, it exhibits the typical holometabolous life cycle.

158. (B) Eggs are laid in distinct clusters on the leaf underside
The cabbage butterfly exhibits a highly characteristic oviposition behavior that is useful for monitoring and managing the pest in cruciferous crops. The adult female typically lays her bright yellow, cigar-shaped eggs in distinct clusters on the lower surface of host leaves. This gregarious egg-laying strategy leads to the emergence of large groups of young larvae, which feed together during early developmental instars.

159. (D) High-protein yeast extract or molasses
Poison baits are an effective component of integrated management for cucurbit fruit flies. These baits typically consist of a concentrated insecticide mixed with a highly attractive food source, such as molasses or high-protein yeast extract. Adult flies are naturally drawn to these substances for energy and reproductive development. Once they feed on the bait, they ingest the toxicant and are killed effectively.

160. (A) Foliar blackening due to mold on honeydew excreta
Besides acting as a viral vector, a severe whitefly infestation in okra fields results in significant indirect damage through the production of honeydew. These sap-sucking insects excrete large quantities of this sticky liquid onto leaf surfaces. The honeydew then serves as a substrate for the growth of Capnodium fungi, which form a thick, black layer of sooty mold that reduces photosynthetic efficiency.

****

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(A) Oilseeds have thinner seed coats that permit rapid fungal entry into the kernel
(B) Oilseeds undergo anaerobic respiration faster than cereals, generating carbon dioxide
(C) Non-lipid fractions concentrate internal moisture, raising the local water activity
(D) High protein content in oilseeds chemically repels water, causing spontaneous combustion

2017

15. Select the logically correct sequence for estimating quantitative weight loss using the Thousand Kernel Weight (TKW) method.
(A) Weigh standardized volume → Count damaged grains → Subject to oven drying → Record final moisture loss
(B) Count 1000 grains from sample → Separate damaged and undamaged grains → Weigh both fractions → Calculate percentage loss using standardized formula
(C) Separate damaged grains → Count remaining undamaged grains → Weigh undamaged fraction → Multiply by predetermined constant
(D) Oven dry sample → Extract hidden insects → Weigh total sample → Count emergence holes

2016

16. Which pair INCORRECTLY matches the pulse beetle species with its primary biological characteristic?
(A) Callosobruchus chinensis - Lays eggs singly, firmly glued to the surface of the pulse seed
(B) Callosobruchus maculatus - Exhibits both an active flight morph and a sedentary morph
(C) Callosobruchus analis - Develops entirely within the cotyledons of various legume seeds
(D) Caryedon serratus - Primarily attacks milled cereal flours and highly processed spices

2022

17. The primary reason Rhyzopertha dominica is considered a highly destructive pest of stored wheat is its ability to:
(A) Attack whole and broken grains with adults and larvae boring into the kernels
(B) Produce abundant silk webs that permanently bind grain sacks together
(C) Vector toxigenic strains of Aspergillus flavus directly into the grain embryo
(D) Survive exclusively on the grain husk without consuming the starchy endosperm

2006

18. Among the following secondary external feeders, which species is characterized by the presence of six prominent tooth-like projections on each side of its thorax?
(A) Tribolium castaneum
(B) Cryptolestes ferrugineus
(C) Oryzaephilus surinamensis
(D) Latheticus oryzae

2010

19. What is the major functional disadvantage of relying solely on structural exclusion (e.g., netting) for avian pest management in godowns?
(A) It fails to address bird populations already nesting inside the roof trusses
(B) It permanently prevents the natural circulation of air necessary for grain cooling
(C) It chemically alters the microclimate, promoting rapid fungal growth on the grain
(D) It actively attracts predatory rodents to the storage premises via chemical cues

2014

20. Read the following lists regarding storage pests and their specific diagnostic damage or biological traits:
List I: (Pest)
P. Sitophilus oryzae
Q. Tribolium castaneum
R. Ephestia cautella
S. Trogoderma granarium
List II: (Trait/Damage)
1. Produces characteristic pinkish flour due to quinone secretions
2. Capable of extended larval diapause deep within structural cracks
3. Adult possesses a distinct rostrum for excavating oviposition holes
4. Larvae produce extensive silken webbing over the surface of bagged grain
Match the following:
(A) P-3, Q-1, R-4, S-2
(B) P-3, Q-4, R-1, S-2
(C) P-2, Q-3, R-1, S-4
(D) P-1, Q-2, R-3, S-4

2022

21. Which stored product pest is primarily notorious for infesting milled, processed products and is recognizable by the bi-colored forewings (inner half pale, outer half coppery-red) of the adult moth?
(A) Sitotroga cerealella
(B) Plodia interpunctella

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uniform moisture

2007

7. Which abiotic factor acts as the primary driver for the multiplication of major storage insect pests in a warehouse environment?
(A) Carbon dioxide concentration
(B) Light intensity and photoperiod
(C) Atmospheric pressure variations
(D) Interstitial grain temperature

2007

8. In evaluating the concept of Equilibrium Moisture Content (EMC), what is the practical significance of the hysteresis effect?
(A) Desorption grains equilibrate at a higher moisture content than adsorption grains at same RH
(B) Grains undergoing adsorption equilibrate at significantly faster rates than those in desorption
(C) The EMC of pulses is immune to fluctuations in ambient temperature due to the hysteresis effect
(D) Hysteresis allows grains to actively repel atmospheric moisture during periods of heavy rainfall

2022

9. Identify the correct statement regarding latent infestation in grain storage systems.
(A) It involves pests migrating rapidly from adjacent heavily infested silos during the monsoon
(B) It refers to developing insect stages hidden inside the kernels at the time of harvest
(C) It refers to the introduction of insect pests during transportation in uncleaned railway wagons
(D) It occurs when secondary feeders opportunistically attack grains previously damaged by fungi

2007

10. Read the given assertion and reason and select the correct option.
Assertion (A): The Equilibrium Moisture Content (EMC) of stored grain is directly dependent on the relative humidity and temperature of the surrounding air.
Reason (R): Grain kernels are hygroscopic materials that continually exchange water vapor with the interstitial air until vapor pressures equalize.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2022

11. Which of the following is an exception to the general rule that insect activity ceases at extreme temperatures?
(A) Trogoderma granarium larvae surviving cold by entering facultative diapause
(B) Sitophilus oryzae adults continuing to mate at a temperature of 5 degrees Celsius
(C) Rhyzopertha dominica eggs hatching rapidly at a temperature of 60 degrees Celsius
(D) Tribolium castaneum actively foraging when the grain bulk exceeds 55 degrees Celsius

2015

12. What distinguishes a primary internal insect feeder from a secondary external feeder in storage entomology?
(A) Primary feeders only consume the germ, whereas secondary feeders consume the endosperm
(B) Primary feeders are exclusively moths, whereas secondary feeders are exclusively beetles
(C) Primary feeders can penetrate sound, whole kernels to feed and develop internally
(D) Primary feeders require previously broken grain, whereas secondary feeders attack sound grain

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2005

13. Which diagnostic symptom is most characteristic of damage caused by Sitotroga cerealella in stored paddy?
(A) The presence of circular exit holes with a distinct sweetish, musty odor in the grain bulk
(B) Severe tunneling accompanied by heavy webbing that binds the kernels together
(C) Extensive superficial scoring on the grain surface with high accumulations of fine white flour
(D) Grains hollowed out from within, leaving a translucent "window pane" of pericarp before adult emergence

2022

14. Which concept application justifies the lower safe moisture threshold prescribed for oilseeds (6-8%) compared to cereals (10-12%)?

than it consumes
(B) Rat droppings, urine trails, and characteristic greasy rub marks are reliable indicators of an active infestation
(C) Rodent incisors grow continuously, compelling them to gnaw on structural materials like wood, plastic, and electrical wiring
(D) Rattus rattus is entirely incapable of scaling vertical walls, limiting its damage strictly to floor-level stacks

2008

30. Which of the following is considered an elimination-based reason for not using purely toxic baits to manage avian pests inside a food grain warehouse?
(A) Toxic baits rapidly lose their chemical efficacy when exposed to godown lighting
(B) The birds do not consume whole grains, rendering the bait useless in this setting
(C) Dead birds falling into the bulk cause biological contamination and foul odors
(D) Avian species lack the digestive enzymes required to process standard rodenticides

2007

31. What is the fundamental psychrometric principle underlying the mechanical forced-aeration drying of grains?
(A) High velocity air crushes pericarps, allowing unbound water to escape the bulk
(B) Heated air increases the vapor pressure gradient to facilitate moisture transfer
(C) Chilled air saturated with moisture forces the grain to naturally expel water
(D) Air circulation equalizes pressure to chemically separate bound water from starch

2023

32. Which feature distinguishes a traditional Pusa bin from a conventional mud bin (Kothi)?
(A) The Pusa bin is constructed entirely from woven bamboo without any mud plaster
(B) The Pusa bin utilizes an active mechanical aeration system driven by rural winds
(C) The Pusa bin is structurally designed to only store pulse crops using repellents
(D) It features a polythene sheet between mud layers to provide a moisture barrier

2014

33. In the context of modern bulk storage, what is the primary operational advantage of constructing concrete silos over corrugated metal silos?
(A) Concrete silos provide superior insulation, reducing fluctuations and condensation
(B) Concrete silos can be seamlessly dismantled and relocated during the off-season
(C) Concrete silos are immune to all forms of fungal growth regardless of moisture
(D) Concrete silos inherently generate insecticidal gas over time via wall reactions

2003

34. What dictates the necessity of maintaining standard alleyway spacing (typically 0.75m to 1m) in a scientifically managed godown?
(A) To provide an exclusive pathway for automated grain sorting machinery in the facility
(B) To create a physical barrier that prevents rodents from leaping between grain stacks
(C) To ensure ventilation, permit inspection, and facilitate spraying or tarping
(D) To allow direct sunlight to naturally dry the bottom-most layers of stacked bag units

2006

35. Consider the following statements regarding the biology and damage potential of Rhyzopertha dominica:
I. It is commonly known as the lesser grain borer.
II. The adult beetle lacks the ability to fly, strictly limiting its dispersal.
III. Both the adult and larval stages voraciously feed on sound, whole grain kernels.
IV. Infestations are often characterized by copious amounts of fine frass and a sweetish odor.
Which of the above statements are correct?
(A) I and II
(B) I, III and IV
(C) I, II and IV
(D) II, III and IV

2016

36. Which pair correctly links the storage pest with its preferred host or high-value commodity?
(A) Callosobruchus chinensis - Unmilled paddy
(B) Sitophilus granarius - Dried copra and oil palm
(C) Trogoderma granarium - Fresh fruits and vegetables
(D) Caryedon serratus - Groundnut pods and tamarind seeds

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2005

37. When comparing modified atmosphere storage (MAS) to traditional chemical fumigation, which statement highlights a key physiological limitation of MAS?
(A) MAS leaves highly toxic residues on the grain surface that must be washed away
(B) MAS requires extended exposure times to achieve mortality via lethal hypoxia
(C) MAS rapidly degrades the gluten quality of stored wheat within a few hours
(D) MAS only works effectively at temperatures significantly below the freezing point

2015

38. Which moisture-proof dunnage material is most widely recommended and utilized in modern bag storage systems to prevent moisture ingress from the godown floor?
(A) Bare concrete blocks spaced uniformly
(B) Woven bamboo mats without any chemical treatment
(C) Wooden crates overlaid with a polythene sheet or specialized mats
(D) A thick layer of untreated paddy husk

2003

39. What is the fundamental mechanism of action by which Purdue Improved Crop Storage (PICS) bags protect stored pulses from bruchid damage?
(A) They are pre-treated with systemic neonicotinoid insecticides that kill adults
(B) They utilize a micro-porous membrane that actively desiccates the insect eggs
(C) They emit volatile botanical repellents integrated into the polyethylene layers
(D) Their hermetic design causes oxygen depletion to asphyxiate the insects

2005

40. Read the given assertion and reason and select the correct option.
Assertion (A): The initial infestation of Callosobruchus species in stored pulses often originates directly from the field before harvest.
Reason (R): Adult bruchids are strong flyers that migrate to maturing pulse crops, laying eggs on the developing pods.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2012

41. In calculating the dosage for prophylactic surface spraying of warehouses, malathion 50% EC is typically diluted and applied at a specific rate. What is the standard application rate for the diluted spray mixture on wall surfaces?
(A) 1 liter per 100 square meters
(B) 3 liters per 100 square meters
(C) 10 liters per 100 square meters
(D) 25 liters per 100 square meters

2016

42. Which chemical detoxification method has proven most effective and is commercially utilized to reduce aflatoxin contamination in animal feed grains?
(A) Treatment with dilute hydrochloric acid
(B) Ammoniation under pressure and high temperature
(C) Fogging with concentrated pyrethrum extract
(D) Ozonation combined with sodium chloride brine

2015

43. Why is mud-plastering or sand-snaking the edges of fumigation covers considered a non-negotiable protocol during curative chemical control?
(A) To ensure gas-tight sealing for maintaining lethal phosphine concentrations
(B) To prevent structural damage to the godown floor by the heavy fumigation tarps
(C) To act as a physical barrier against rodents attempting to consume the tablets
(D) To chemically neutralize the acidic byproducts of aluminium phosphide breakdown

2016

44. Which of the following is NOT a recognized biochemical or behavioral mechanism of phosphine resistance in stored product insects?
(A) Reduced respiratory uptake of phosphine gas due to diminished spiracular activity
(B) Alterations in the core metabolic enzyme dihydrolipoamide dehydrogenase (DLD)
(C) Enhanced metabolic detoxification of the phosphine molecule via specialized esterases
(D) Active behavioral avoidance where insects migrate to non-fumigated zones

NODIA

2017

45. What is the primary limitation of utilizing the predatory bug Xylocoris flavipes for biological control in large-scale commercial bulk storage?
(A) It exclusively feeds on fungal spores and

ignores insect larvae
(B) It requires a constant supply of fresh water to reproduce
(C) It rapidly defoliates any botanical products stored in the facility
(D) It restricts its predatory activity to the surface layers of the mass

2021

46. A compartmentalized grain trier (probe) is predominantly utilized for which specific pest monitoring task?
(A) Trapping adult moths in flight within the upper airspace of the warehouse facility
(B) Measuring the absolute concentration of phosphine gas during the fumigation cycle
(C) Extracting samples from distinct depths of a bulk to assess localized infestation
(D) Detecting the acoustic emissions of internally feeding larvae in grain kernels

2006

47. Which statement correctly identifies a practice that is NOT recommended in the management of Cover and Plinth (CAP) storage logistics?
(A) Elevating the plinth above ground level to prevent waterlogging during rains
(B) Using CAP storage for the indefinite multi-year storage of highly hygroscopic milled flours
(C) Securing the low-density polyethylene (LDPE) covers tightly with lashing nets to prevent wind damage
(D) Utilizing wooden crates as dunnage atop the brick plinth to prevent ground moisture transfer

2002

48. In the integrated pest management (IPM) of storage godowns, what is the conceptual difference between a pitfall trap and a probe trap?
(A) Pitfall traps are used exclusively for rodents, while probe traps are used for insects
(B) Pitfall traps chemically lure flying insects, while probe traps physically ensnare crawling insects
(C) Pitfall traps measure temperature, whereas probe traps measure moisture
(D) Pitfalls capture insects on the surface, while probes capture those moving in the bulk

2019

49. Which of the following best describes the principle of 'cross-infestation' in warehouse management?
(A) Pest migration from infested lots or structures to uninfested clean grain
(B) The genetic crossing of two distinct insect pest species to form a resistant hybrid
(C) The simultaneous attack on a grain kernel by both a primary and a secondary feeder
(D) The transfer of pests directly from the agricultural field to the transport vector

2015

50. Read the following lists regarding grain drying techniques and their characteristics:
List I: (Technique)
P. Deep-bed drying
Q. Thin-layer drying
R. Solar drying
S. Forced aeration
List II: (Characteristic)
1. Relies on natural UV exposure but suffers from inconsistent weather-dependent rates
2. Creates a distinct moisture gradient moving upward from the air inlet to the exhaust
3. Utilizes ambient or slightly modified air primarily to cool grain and equalize moisture, not rapidly dry
4. Exposes individual kernels fully to the drying air, allowing maximum rapid moisture loss without gradients
Match the following:
(A) P-2, Q-4, R-1, S-3
(B) P-4, Q-2, R-3, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-3, R-1, S-4

2021

51. The phenomenon of "active resistance" to phosphine, as defined by FAO protocols, typically implies that the insect population:
(A) Survives diagnostic doses and requires higher concentrations for mortality
(B) Actively attacks and destroys the aluminium phosphide tablets before they decompose
(C) Has developed a thicker exoskeleton that completely prevents gas penetration
(D) Only exhibits resistance when exposed to a mixture of phosphine and malathion

2008

52. Which mechanism explains why extreme low-temperature treatments (below -10 degrees C) are an effective physical control method for stored grain pests?
(A) It causes the rapid expansion and vaporization of hemolymph, bursting the insect cuticle

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(B) It forces insects into an hyperactive metabolic state, rapidly exhausting their fat reserves
(C) It structurally alters the grain starch, making it completely indigestible to pests
(D) It induces ice crystallization in cells, leading to mechanical damage and death

2001

53. Identify the primary target organ and associated disease in humans caused by the ingestion of aflatoxin B1.
(A) The kidneys, leading to Balkan endemic nephropathy
(B) The liver, leading to hepatocellular carcinoma
(C) The nervous system, leading to acute leukoencephalomalacia
(D) The respiratory system, leading to pulmonary aspergillosis

2019

54. When sampling grain using a standard compartmentalized probe, why is it critical to insert the probe in a closed position and open it only once it reaches the desired depth?
(A) To prevent the probe from bending under the immense pressure of the bulk grain
(B) To avoid structurally crushing the delicate grain kernels situated on the surface
(C) To ensure the sample represents a specific stratum rather than a mixed column
(D) To trap gaseous fumigants securely within the compartments for later chemical analysis

2006

55. Determine the correct chronological sequence of developmental stages and behavioral events in the life cycle of Trogoderma granarium in a storage environment.
(A) Egg deposition → Facultative diapause → Active larval feeding → Adult emergence → Pupation
(B) Active larval feeding → Egg deposition → Pupation → Short-lived adult emergence → Facultative diapause
(C) Egg deposition → Pupation → Active larval feeding → Facultative diapause → Short-lived adult emergence
(D) Egg deposition → Active larval feeding → Facultative diapause deep in crevices → Pupation → Short-lived adult emergence

2004

56. Which of the following pests is NOT classified as a primary internal feeder?
(A) Cryptolestes ferrugineus
(B) Sitophilus zeamais
(C) Rhyzopertha dominica
(D) Sitotroga cerealella

2012

57. The use of ionizing radiation (such as Gamma rays) for the disinfestation of stored products primarily functions by:
(A) Physically burning the exoskeleton of the adult insects through high thermal energy
(B) Inducing reproductive sterility or somatic death by damaging insect cellular DNA
(C) Leaving behind a mildly radioactive residue that repels secondary infestations in silos
(D) Creating an impenetrable hermetic seal around the grain packaging during treatment

2005

58. How does the plant derivative Acorus calamus (sweet flag) predominantly exert its insecticidal effect on storage pests?
(A) It acts as a potent fumigant that treats areas deep within the storage environment
(B) Its active principle, beta-asarone, exhibits strong contact toxicity and anti-gonadal properties
(C) It produces massive quantities of carbon dioxide that asphyxiate larvae
(D) Its active principle, azadirachtin, functions as a powerful chitin synthesis inhibitor

2002

59. Which of the following best defines the Maximum Residue Limit (MRL) in the context of prophylactic chemical treatments of stored food grains?
(A) The highest concentration of a pesticide legally permitted in or on food commodities, considered safe for human consumption
(B) The maximum amount of insecticide that can be applied to a warehouse wall before structural degradation occurs
(C) The minimum dose of a chemical required to kill 99% of the pest population
(D) The legal limit of insect fragments allowable in milled wheat flour

2003

60. Identify the INCORRECT statement regarding the application and safety protocols of Aluminium phosphide (phosphine).
(A) Phosphine gas is roughly 1.2 times heavier than air, allowing it to slowly penetrate downward through the grain mass

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(B) Aluminium phosphide tablets react with ambient moisture to release phosphine gas, ammonia, and carbon dioxide
(C) Phosphine gas is completely non-flammable and poses zero risk of auto-ignition regardless of its concentration in the air
(D) A standard 3-gram tablet of commercial Aluminium phosphide yields approximately 1 gram of active phosphine gas

2004

61. What is the fundamental difference between multiple resistance and cross-resistance in storage pest populations?
(A) Multiple resistance involves resistance to multiple life stages, whereas cross-resistance applies only to the adult stage
(B) Multiple resistance occurs when independent mechanisms confer resistance to distinct insecticide classes, whereas cross-resistance involves a single mechanism conferring resistance to related insecticides
(C) Multiple resistance is genetically inherited, whereas cross-resistance is strictly acquired through behavioral adaptation
(D) Multiple resistance involves behavioral adaptations, whereas cross-resistance involves the mutation of single target-site enzymes

2010

62. Which of the following is an advantage of using pheromone lures for the early detection of pests in a warehouse?
(A) They instantly eradicate the entire pest population without chemical residues
(B) They are completely unaffected by intense dust and high airflow within the storage facility
(C) They are species-specific and can detect pests at very low densities before damage
(D) They structurally alter the grain to make it completely unpalatable to incoming pests

2010

63. According to typical Food Corporation of India (FCI) inspection protocols, grain categorisation based on the percentage of weevilled grains generally employs which set of descriptive grades?
(A) A-grade, B-grade, C-grade, D-grade
(B) Clean, Lightly weevilled, Heavily weevilled, Condemned
(C) Clear, Few, Heavy
(D) Pristine, Minor, Major, Complete loss

2014

64. What is the main cause of the phenomenon known as "bin burn" in bulk grain silos?
(A) Spontaneous combustion triggered by excessive chemical fumigation
(B) Over-exposure of the corrugated metal silo to direct summer solar radiation
(C) Friction caused by the rapid operation of the sweep auger during grain offloading
(D) Intense heat generated by fungal respiration and metabolism in high-moisture pockets

2004

65. Consider the following statements regarding mycotoxins in stored products:
I. Aflatoxins are primarily produced by Aspergillus flavus and Aspergillus parasiticus.
II. Ochratoxins predominantly target the central nervous system in horses.
III. Fungal growth strictly ceases at temperatures below freezing, completely stopping mycotoxin biosynthesis.
Which of the above statements are correct?
(A) II and III
(B) I and II
(C) I and III
(D) I only

2014

66. Which structural exclusion technique is specifically deployed to prevent rodents from climbing external pipes or cables to access godown ventilation ports?
(A) Installing ultrasonic emitting devices along the perimeter wall
(B) Applying heavy coats of deltamethrin spray to all structural columns
(C) Affixing smooth, inverted metal cone guards (rat guards) on vertical entry routes
(D) Sealing the entire base of the godown with high-density polyurethane foam

2017

67. In bag storage warehouses, the scientific block stacking pattern is strictly preferred over random stacking because it:
(A) Ensures structural stability and enables precise stock counting and gas sealing
(B) Naturally generates insecticidal gases through the alignment of jute fibers
(C) Entirely eliminates the need for any chemical pest control interventions
(D) Increases the relative humidity within the center of the stack to prevent over-drying

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agricultural chaff
(B) Specialized wooden crates
(C) Polyethylene-layered bamboo mats
(D) Heavy gauge polythene sheets

2011

114. How does the "block stacking" pattern structurally ensure the stability of a 15-layer high stack of 50kg grain bags?
(A) By tying all the bags together using a continuous steel cable
(B) By aligning all bags perfectly parallel to each other in every single layer
(C) By alternating bag orientation in successive layers to create a bonded structure
(D) By chemically gluing the jute bags together using synthetic adhesives

2009

115. Arrange the operational steps for establishing a new scientific bag storage stack in a godown in the correct sequence.
(A) Clean floor → Apply prophylactic wall spray → Lay moisture-proof dunnage → Build stack using interlocking pattern → Maintain required alleyways
(B) Lay dunnage → Clean floor → Build stack cross-wise → Apply prophylactic wall spray → Tarp for fumigation
(C) Apply prophylactic wall spray → Build stack using interlocking pattern → Lay dunnage → Tarp for fumigation → Clean floor
(D) Build stack using interlocking pattern → Lay dunnage → Clean floor → Maintain required alleyways → Apply prophylactic wall spray

2001

116. The fundamental principle governing Hermetic storage technology is the absolute physical exclusion of external air, which rapidly leads to:
(A) A massive increase in the internal vapor pressure causing the immediate implosion of the grain kernel
(B) The complete chemical breakdown of all grain proteins into free amino acids
(C) The spontaneous creation of insecticidal ozone gas within the sealed space
(D) A lethal accumulation of carbon dioxide and depletion of oxygen due to the respiration of grain, insects, and microflora

2007

117. What specifically constitutes the structural design of a Purdue Improved Crop Storage (PICS) bag?
(A) A single extremely thick layer of woven jute treated with pure deltamethrin
(B) Two HDPE inner layers enclosed in a protective outer woven polypropylene sack
(C) A rigid inner core of galvanized iron surrounded by woven bamboo
(D) Three layers of micro-porous breathable cotton to allow continuous moisture escape

2013

118. When comparing Modified Atmosphere Storage (MAS) with Controlled Atmosphere Storage (CAS), what distinguishing feature applies to CAS?
(A) CAS relies solely on the natural respiration of the insects to alter the atmosphere
(B) CAS is heavily dependent on the application of synthetic pyrethroid sprays
(C) CAS actively regulates gas concentrations (e.g. N2 or CO2) at predetermined levels
(D) CAS involves permanently flooding the grain bulk with liquid nitrogen

2021

119. Identify the correct statement regarding the application of ionizing radiation for the disinfestation of stored grains.
(A) It requires the grain to be heated to 100 degrees Celsius prior to irradiation
(B) It is entirely ineffective against the egg and pupal stages of primary internal feeders
(C) It inherently provides lifelong protection against subsequent re-infestation
(D) It causes reproductive sterility or mortality without leaving chemical residues

2011

120. Which of the following provides the most relevant elimination-based argument against relying solely on extreme cold treatments (below 0°C) for large-scale grain bulk storage in tropical climates?
(A) Refrigerating thousands of tonnes of grain requires prohibitive energy expenditure
(B) Cold treatments rapidly and permanently destroy the natural flavor of paddy
(C) Pests immediately mutate and become immune to freezing within a single generation
(D) Freezing grain causes it to instantly combust when exposed to room temperature air

2006

121. What is the precise physiological consequence of severe hypoxia on insect pests sealed inside a hermetic storage structure?

NODIA

2022

76. Which of the following adverse effects is primarily caused by under-dosing a fumigant like phosphine in a poorly sealed godown?
(A) Immediate spontaneous combustion of the grain bulk
(B) The rapid conversion of the phosphine gas into highly toxic phosgene gas
(C) Survival of tolerant individuals, leading to genetic selection for resistance
(D) The permanent discoloration of the grain pericarp to a dark brown hue

2005

77. When comparing the morphological traits of storage mites with those of primary storage insects, which feature correctly distinguishes adult mites?
(A) Mites possess three body segments (head, thorax, abdomen) whereas insects possess two
(B) Mites are equipped with strong, heavily sclerotized mandibles for boring, whereas insects rely solely on piercing-sucking mouthparts
(C) Mites exclusively develop wings in their final adult stage for dispersal
(D) Mites typically possess four pairs of legs and lack antennae, whereas insects possess three pairs of legs and one pair of antennae

2016

78. Which traditional rural storage structure is specifically characterized as an outdoor, elevated, circular receptacle made of plant materials like bamboo or straw, primarily used for storing unthreshed paddy in eastern and southern India?
(A) Kothi
(B) Bukhari
(C) Morai
(D) Pusa bin

2006

79. What specific type of qualitative degradation occurs when stored grains are subjected to severe, prolonged infestation by Tribolium castaneum?
(A) The grains become highly radioactive due to the accumulation of heavy metals
(B) The flour acquires a pungent odor and turns pinkish due to benzoquinone secretion
(C) The starch is completely converted into free glucose, rendering the grain excessively sweet
(D) The grain rapidly sprouts, utilizing all stored energy reserves

2014

80. Read the following lists regarding storage rodent species and their common names or behavioral traits:
List I: (Species)
P. Rattus rattus
Q. Mus musculus
R. Bandicota bengalensis
S. Rattus norvegicus
List II: (Trait/Common Name)
1. House mouse; known for erratic nibbling and small home ranges
2. Lesser bandicoot rat; notorious for aggressive hoarding behavior in deep burrows
3. Roof rat/Black rat; highly agile climber preferring elevated nesting sites
4. Norway rat/Brown rat; strong swimmer and burrower often found in sewers and ground levels
Match the following:
(A) P-1, Q-3, R-2, S-4
(B) P-3, Q-1, R-2, S-4
(C) P-3, Q-2, R-1, S-4
(D) P-4, Q-1, R-3, S-2

2011

81. The implementation of quarantine regulations under the Destructive Insects and Pests (DIP) Act in India serves primarily to:
(A) Prevent the spread of exotic storage pests across international or domestic borders
(B) Ensure all farmers use identical storage structures across the country
(C) Mandate the use of genetically modified grain varieties that are insecticidal
(D) Subsidize the cost of chemical fumigants for small-scale rural farmers

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2009

82. Which of the following is NOT a characteristic sign of structural damage or active infestation by rodent pests in a grain storage facility?
(A) Greasy smear marks along the lower edges of walls and structural beams
(B) Gnawed holes at the base of wooden doors and torn jute sacks
(C) Accumulation of dense silken webbing over the surface of stacked gunny bags
(D) Presence of spindle-shaped, dark fecal droppings scattered near grain spillage

2011

83. When implementing a rodenticide baiting program using an acute toxicant like Zinc

phosphide, why is "pre-baiting" strongly recommended?
(A) To overcome natural neophobia and ensure rodents consume a lethal toxic dose
(B) To chemically prime the rodents' digestive systems to absorb the poison faster
(C) To immediately kill off the weakest rodents before the main poison is deployed
(D) To attract predatory birds into the godown to assist with the pest control

2017

84. In the context of avian pests in storage godowns, which of the following is the most direct cause of grain contamination rendering the product unfit for human consumption?
(A) Depletion of interstitial oxygen by bird respiration
(B) The physical removal of the germ portion by selective pecking
(C) The transmission of viral plant pathogens to the dormant grain seeds
(D) Accumulation of feathers, debris, and uric-acid-rich feces on grain surfaces

2023

85. Consider the following statements regarding avian deterrent and exclusion techniques:
I. Polyethylene netting effectively physically excludes birds from entering godown ventilators.
II. Ultrasonic deterrents are a highly reliable, permanent solution as birds never habituate to the sound.
III. Anti-roosting spikes alter the physical structure of beams to prevent pigeons from landing and nesting.
IV. Toxic baits are universally approved and preferred for controlling birds directly inside food grain warehouses.
Which of the above statements are correct?
(A) II and IV
(B) I, II and IV
(C) I and III
(D) II, III and IV

2012

86. Which of the following bird species is most notoriously associated with roosting and contaminating bulk and bag storage facilities in urban and semi-urban settings?
(A) Passer domesticus (House sparrow)
(B) Corvus splendens (House crow)
(C) Columba livia (Rock pigeon)
(D) Psittacula krameri (Rose-ringed parakeet)

2003

87. Identify the INCORRECT pair regarding physical and ecological control methods.
(A) Hermetic storage - Depletes O2 and increases CO2 via respiration
(B) Ionizing radiation - Utilizes gamma rays to induce sterility or somatic death in insects
(C) Heating - Exposing grain to 50–60 degrees Celsius to lethally denature insect proteins
(D) Modified Atmosphere Storage (MAS) - Involves constantly pumping ambient outside air to permanently chill the grain to freezing point

2021

88. Why is structural exclusion considered the most critical component of avian pest management in food storage facilities?
(A) Lethal control inside food storage poses high risks of biological contamination
(B) It chemically repels the birds without affecting the grain
(C) It is the only legally mandated method for all private farmers
(D) Birds possess a high natural immunity to all known toxicant gases used in fumigation

2006

89. Which of the following is considered an elimination-based rationale against the extensive use of continuous high-heat treatment (above 65 degrees Celsius) for disinfesting seed grain?
(A) It fails to kill the egg stage of storage insects
(B) It denatures vital proteins and destroys the viability and germination capacity
(C) It promotes the immediate hyper-proliferation of Aspergillus fungi
(D) It structurally causes the grain to absorb massive amounts of moisture from the air

2005

90. Psychrometrics, in the context of grain drying, is primarily the study of:
(A) The psychological behavior of insects under stress
(B) The thermodynamic properties of air and water vapor in moisture transfer
(C) The measurement of friction within a moving column of bulk grains
(D) The precise timing of chemical degradation in pesticide residues

2010

91. What is the fundamental difference between thin-layer drying and deep-bed drying of grains?
(A) Thin-layer exposes every kernel to drying

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air, while deep-bed creates zones
(B) Thin-layer drying is entirely dependent on solar radiation while mechanical fans drive deep-bed
(C) Deep-bed drying assumes uniform moisture loss simultaneously across all grains in the silo
(D) Deep-bed drying is only applicable to oilseeds, whereas thin-layer drying is for pulses

2025

92. The primary objective of operating forced aeration mechanisms in modern bulk silos during winter storage is to:
(A) Rapidly remove 5-10% of the grain moisture content within a few hours
(B) Extract volatile mycotoxins entirely from the grain bulk
(C) Cool the grain mass uniformly to prevent temperature gradients and condensation
(D) Generate sufficient friction to permanently polish the outer grain pericarp

2014

93. Over-drying cereal grains, particularly paddy, at excessively high temperatures commonly results in which detrimental physical defect?
(A) Complete liquefaction of the starchy endosperm
(B) Immediate spontaneous germination of the grain embryo
(C) A permanent increase in the intrinsic water activity of the grain
(D) The development of severe stress cracks, leading to high milling breakage

2005

94. Which statement correctly identifies a significant limitation of traditional sun/solar drying of grains?
(A) It systematically destroys all the natural vitamins present in the grain within minutes
(B) It requires highly specialized, expensive electrical equipment to maintain the drying temperature
(C) It relies on unpredictable weather and exposes grain to contamination and pests
(D) It inherently causes a massive increase in the internal moisture content during the afternoon

2015

95. Identify the INCORRECT combination of statements regarding the factors that influence the drying rate of grain.
I. A higher velocity of drying air decreases the drying rate by cooling the grain too quickly.
II. Lower ambient relative humidity increases the capacity of the air to absorb moisture from the grain.
III. High initial grain moisture content slows down the initial drying phase due to surface tension.
IV. The intrinsic physical shape and size of the grain kernel have no effect on its drying rate.
(A) I, III and IV
(B) II, III and IV
(C) I and II
(D) I, II and IV

2018

96. In a deep-bed drying system, the "drying front" is best defined as:
(A) The physical metallic barrier at the top of the silo that prevents grain spillage
(B) The immediate external layer of grain that is exposed to direct sunlight
(C) The boundary layer of high insect density attempting to escape the heated air
(D) The transitional zone moving with airflow that separates dry grain from wet

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2018

97. The structural design of the PAU (Punjab Agricultural University) bin is primarily characterized by the use of:
(A) Galvanized metal sheets forming a rigid, rat-proof, and relatively airtight container
(B) Woven bamboo heavily coated with a thick layer of cow dung
(C) Mud bricks sandwiching a core of highly porous sand for natural cooling
(D) Flexible, triple-layered high-density polyethylene sacks

2004

98. Identify the INCORRECT statement comparing traditional rural storage structures.
(A) The Bukhari is generally constructed outdoors using bamboo or timber and is elevated to protect against ground moisture
(B) The Kothi is typically an indoor structure used for storing smaller quantities of grain or seeds
(C) The traditional mud bin is entirely impervious to rodent attacks and completely

prevents moisture ingress from the soil
(D) Traditional structures often suffer from poor gas-tightness, making effective chemical fumigation difficult

2016

99. What specific functional role does the polythene sheet play in the construction of the improved Pusa bin?
(A) It acts as a physical barrier preventing grain from absorbing moisture vapor
(B) It acts as a selective membrane allowing oxygen in while keeping carbon dioxide out
(C) It naturally repels primary internal feeders through the emission of plasticizer odors
(D) It physically reinforces the mud walls to withstand major seismic activity

2019

100. Read the given assertion and reason and select the correct option.
Assertion (A): Traditional earthen mud bins often fail to protect stored grains from rapid mold growth during the monsoon season.
Reason (R): Earthen walls are highly porous and readily absorb and transmit atmospheric moisture directly into the stored grain bulk.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2001

101. Which of the following is considered a primary structural demerit of traditional storage systems like the basic Morai or unlined bamboo bins?
(A) They are excessively expensive to build, requiring imported materials
(B) They are susceptible to rodents, cross-infestation, and lack gas-tightness
(C) They cause the grain to undergo spontaneous chemical bleaching
(D) They inherently generate dangerously high levels of lethal carbon monoxide gas

2017

102. When deploying a Modified Atmosphere Storage (MAS) system using carbon dioxide, why is a high initial purge rate crucial?
(A) To immediately dissolve the external insect cuticle through extreme acidity
(B) To permanently freeze the grain kernel, locking the moisture inside
(C) To displace interstitial oxygen before pests enter protective metabolic torpor
(D) To chemically convert all the starch into inert cellulose

2021

103. In modern bulk storage systems, what critical phenomenon occurs as a result of significant diurnal temperature fluctuations on the exterior of a corrugated metal silo?
(A) The immediate breakdown of the grain's internal protein structure
(B) The spontaneous generation of highly volatile phosphine gas from the grain dust
(C) The permanent contraction of the metal walls, crushing the grain bulk
(D) Temperature gradients leading to convection, moisture migration, and sweating

2018

104. The Cover and Plinth (CAP) storage logistics system is predominantly utilized in India for which specific purpose?
(A) Large-scale transit and buffer storage of bagged cereal grains during overflow
(B) The permanent, multi-decade strategic reserve storage of highly milled flour and processed spices
(C) The specialized cryogenic preservation of high-value genetically modified seed germplasm
(D) The rapid artificial drying of wet grain freshly harvested during heavy rains

2016

105. Select the correct sequence of mechanical operations for loading grain into a typical modern concrete bulk silo.
(A) Sweep auger → Bucket elevator → Upper conveyor → Distributor/Spout → Silo bin
(B) Intake hopper → Bucket elevator → Upper conveyor → Distributor/Spout → Silo bin
(C) Intake hopper → Lower drag conveyor → Sweep auger → Distributor → Silo bin
(D) Bucket elevator → Intake hopper → Sweep auger → Lower drag conveyor → Silo bin

2023

106. Identify the correct pair linking a bulk silo component with its primary function.
(A) Headspace extractor fan - Moves grain vertically from the intake pit to the top conveyor
(B) Sweep auger - Clears residual grain in flat-bottom silos to the central discharge

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(C) Bucket elevator - Distributes gaseous fumigant evenly throughout the bulk
(D) Temperature cable - Monitors the exact structural tension and stress on the concrete walls

2021

107. Which of the following is NOT considered a significant operational advantage of the Cover and Plinth (CAP) storage system?
(A) It provides permanent protection against all avian pests and rodent tunneling
(B) It is highly economical and can be set up rapidly on open land
(C) It utilizes locally available materials for dunnage and covers
(D) It easily accommodates massive surges in grain procurement that exceed permanent silo capacity

2022

108. What is the primary cause of moisture condensation, often referred to as "headspace sweating", inside a metal silo during the onset of winter?
(A) Pumping excessively dry ambient air through the bottom aeration fans physically pushes liquid water out of the grain and up to the roof
(B) The rapid chemical decomposition of aluminium phosphide releases massive volumes of liquid water
(C) Warm air rising from the bulk center contacts the cold roof and releases water
(D) Fungal spores naturally exude massive droplets of water when exposed to cold temperatures

2014

109. What is the most appropriate primary intervention for managing a localized "hot spot" discovered via temperature cables deep within a bulk silo?
(A) Immediately opening the roof hatches to let natural sunlight heat the rest of the grain
(B) Flooding the entire silo with liquid water to cool the hot grain
(C) Applying heavy surface sprays of malathion directly onto the silo roof
(D) Activating aeration fans to draw cool air and dissipate heat to equalize temperature

2006

110. Read the following lists regarding scientific bag stacking terminology and its application:

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List I: (Term)
P. Block stacking
Q. Dunnage
R. Alleyway
S. Tarping
List II: (Definition/Application)
1. The clear space maintained between distinct stacks and between stacks and walls for inspection and airflow
2. The process of completely covering a stack with a gas-proof cover for fumigation
3. Moisture-proof foundational materials placed on the floor before stacking bags
4. A structured method of cross-laying bags layer by layer to ensure strict stability and prevent collapse

Match the following:
(A) P-4, Q-1, R-3, S-2
(B) P-3, Q-4, R-2, S-1
(C) P-4, Q-3, R-1, S-2
(D) P-1, Q-2, R-4, S-3

2019

111. What is the standard designated storage capacity of a typical, single standard-sized godown compartment (often measuring roughly 125×70 feet internally)?
(A) 500 Metric Tonnes (MT)
(B) 5,000 Metric Tonnes (MT)
(C) 50,000 Metric Tonnes (MT)
(D) 500,000 Metric Tonnes (MT)

2023

112. Identify the INCORRECT statement regarding the standard operating procedures for alleyway spacing in a scientific bag storage warehouse.
(A) Alleyways facilitate visual inspection for signs of pest infestation and structural damage
(B) Standard peripheral alleyways (between stack and wall) are typically maintained at 0.75 to 1.0 meters wide
(C) Central alleyways must be wide enough to allow the movement of labor and handling equipment
(D) Alleyways are intentionally filled with loose, heavily infested grain to act as a trap for migrating insects

2002

113. Which material is strictly prohibited for use as direct, unprotected dunnage in a modern scientific warehouse due to its high capacity to harbor moisture and hidden pests?
(A) Loose, damp straw or unprocessed

2007

68. Which biological agent is a naturally occurring hymenopteran parasitoid commonly known to attack the larvae of primary internal feeders like Sitophilus spp.?
(A) Xylocoris flavipes
(B) Tribolium castaneum
(C) Tyrophagus putrescentiae
(D) Anisopteromalus calandrae

2015

69. Which of the following is NOT considered an abiotic factor influencing grain deterioration during storage?
(A) Interstitial grain temperature
(B) The initial population density of Sitophilus weevils
(C) Ambient relative humidity
(D) Moisture content of the grain

2003

70. Read the given assertion and reason and select the correct option.
Assertion (A): Stored product insects like Tribolium castaneum cannot initiate an infestation on perfectly sound, whole wheat kernels.
Reason (R): Secondary external feeders lack the specialized morphological adaptations, such as a strong rostrum or powerful mandibles, required to penetrate the intact pericarp.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2005

71. The parasitoid wasp Anisopteromalus calandrae locates its hidden larval host inside the grain kernel primarily by:
(A) Visually detecting the discoloration on the grain surface caused by fungal growth
(B) Following the distinct infrared heat signature emitted by the actively feeding larva
(C) Randomly drilling into every grain kernel until a host is mechanically encountered
(D) Detecting semiochemicals and vibrations produced by the internally feeding host larva

2003

72. Which of the following accurately describes the behavior of Plodia interpunctella (Indian meal moth) larvae in a processed food facility?
(A) They wander extensively and secrete copious silk, often webbing the surface heavily
(B) They bore deep into the center of bulk grain silos to pupate
(C) They remain strictly sedentary, feeding only on the exact spot where the egg was laid
(D) They secrete defensive quinones that cause a permanent pink discoloration of the flour

2004

73. What is the fundamental difference between the action thresholds for primary internal feeders versus secondary external feeders in grain intended for long-term seed viability?
(A) Primary feeders have a much higher threshold because they only consume the husk
(B) Primary thresholds are near zero as they destroy embryos and cause hidden loss
(C) Secondary feeders are given a lower threshold because they are vectors for deadly mycotoxins
(D) There is no difference; action thresholds are determined strictly by grain volume

2005

74. Identify the INCORRECT statement regarding the application of neem (Azadirachta indica) derivatives in storage pest management.
(A) Neem Seed Kernel Extract (NSKE) acts primarily as an antifeedant and insect growth regulator
(B) Azadirachtin functions rapidly as a highly lethal contact poison, dropping adult insects instantly upon application
(C) Coating pulses with neem oil is a traditional prophylactic measure to inhibit bruchid oviposition and egg hatching
(D) Neem formulations generally leave no toxic residues harmful to humans on treated pulses

2006

75. In the calculation of required grain sampling intensity, a common statistical rule of thumb for determining the number of bags to be sampled from a given lot is:
(A) Sample the square root of the total number of bags in the lot
(B) Sample only the four corner bags of the entire stack
(C) Sample exactly 1% of the total bags regardless of the lot size
(D) Sample every single bag located on the top layer of the stack

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(A) They rapidly grow specialized gills to filter oxygen from water vapor
(B) Their spiracles stay open for oxygen, leading to rapid and fatal desiccation
(C) They undergo accelerated metamorphosis, emerging as stunted adults
(D) Their spiracles remain permanently closed, causing lethal internal buildup of carbon dioxide

2001

122. Under standard prophylactic treatment protocols, what is the generally recommended concentration of the malathion working solution for spraying empty godown surfaces?
(A) 0.01%
(B) 0.1%
(C) 0.5%
(D) 5.0%

2015

123. The significance of strictly adhering to the Maximum Residue Limit (MRL) when utilizing approved grain protectants like deltamethrin lies primarily in:
(A) Ensuring residual chemical concentration on the commodity remains safe for humans
(B) Preventing the rapid structural corrosion of the metal storage silo
(C) Guaranteeing that the chemical immediately kills all invading rodents
(D) Maximizing the permanent visual discoloration of the grain to indicate it has been treated

2001

124. Identify the INCORRECT pair linking the chemical pesticide with its functional categorization in storage entomology.
(A) Aluminium phosphide - Curative Fumigant
(B) Deltamethrin - Prophylactic grain protectant / Surface spray
(C) Methyl bromide - Botanical antifeedant
(D) Malathion - Organophosphate contact insecticide

2023

125. Consider the following statements regarding warehouse sanitation and prophylactic treatments:
I. Complete removal of old grain spillage and structural residues is essential before applying surface sprays.
II. Prophylactic sprays are highly effective at completely eliminating deep-seated internal infestations inside the grain kernel.
III. Fabric spraying involves treating the external surface of the stacked gunny bags to prevent cross-infestation.
Which of the above statements are correct?
(A) I and III
(B) I, II and III
(C) II and III
(D) I only

2005

126. In the context of prophylactic chemical control in a bag storage facility, "fabric spraying" specifically refers to:
(A) Spraying the clothing of warehouse workers with heavy doses of malathion
(B) Treating the cotton filters inside the mechanical aeration fans
(C) Spraying an approved contact insecticide directly onto the exposed surfaces of the stacked gunny/jute bags
(D) Chemically treating the high-density polyethylene covers used for fumigation to make them gas-tight

2001

127. Which of the following chemicals is no longer approved or widely recommended for direct admixture as a grain protectant on food grains destined for human consumption due to high mammalian toxicity or environmental persistence?
(A) Spinosad
(B) DDT
(C) Deltamethrin
(D) Diatomaceous earth

2017

128. From the known properties of synthetic pyrethroids, infer why deltamethrin is often preferred over malathion for controlling certain storage pests.
(A) Deltamethrin actively vaporizes to act as a highly penetrating fumigant deep within the bulk
(B) Deltamethrin is a naturally occurring plant extract that leaves absolutely zero chemical residue
(C) Deltamethrin exclusively kills pests by severely depressing their respiratory centers, acting solely as a gas
(D) It exhibits high residual efficacy on surfaces and works against malathion-resistant species

NODIA

2001

129. When exposed to atmospheric moisture, the decomposition of commercial Aluminium phosphide tablets releases phosphine gas. What visually distinct byproduct is left behind as a residual dust?
(A) A grayish-white powder primarily composed of non-toxic aluminium hydroxide
(B) Pure crystalline sulfur found near the site of the original tablet application
(C) A highly volatile yellow liquid that collects at the bottom of the stack
(D) A sticky black carbonaceous tar that adheres to the grain kernel surfaces

2007

130. Read the given assertion and reason and select the correct option.
Assertion (A): The technique of mud-plastering or using heavy sand snakes around the base of a fumigation cover is critical to achieving successful pest mortality.
Reason (R): Phosphine gas is highly penetrative and readily escapes from poorly sealed enclosures, preventing the concentration from reaching and maintaining the lethal threshold over the required exposure period.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019

131. Identify the correct statement regarding the safety protocols and chemical properties of phosphine gas.
(A) Pure gas is spontaneously flammable in air at concentrations exceeding 1.79% (v/v)
(B) Phosphine is entirely odorless, requiring workers to rely completely on visual symptoms of poisoning
(C) Phosphine reacts vigorously with all plastics, instantly dissolving polyethylene tarpaulins
(D) Phosphine gas is lighter than helium, causing it to exclusively accumulate at the roof of the silo

2023

132. What is the most likely outcome of a gas-tight tarping failure during a curative fumigation process?
(A) The rapid conversion of the entire grain bulk into a highly toxic mass
(B) The immediate mechanical collapse of the stacked bags due to massive internal gas pressure loss
(C) The instantaneous spontaneous combustion of the residual aluminium hydroxide powder
(D) Survival of tolerant life stages, leading to resurgence and selection for resistance

2016

133. According to typical occupational safety standards, what is the generally accepted Threshold Limit Value (TLV) for human exposure to phosphine gas over an 8-hour workday?
(A) 0.01 ppm
(B) 0.3 ppm
(C) 10.0 ppm
(D) 100.0 ppm

2018

134. Which of the following is considered an elimination-based factor that drastically reduces the biological efficacy of a phosphine fumigation operation?
(A) Conducting the fumigation during the peak heat of mid-summer
(B) Ensuring a completely hermetic seal around the entire grain stack
(C) Fumigating at cold temperatures (below 5°C) where insect metabolic rates are depressed
(D) Using freshly opened, un-degraded aluminium phosphide tablets

2025

135. The primary genetic mechanism responsible for high-level phosphine resistance in several strains of stored product pests (such as Rhyzopertha dominica and Tribolium castaneum) involves:
(A) The physical thickening of the insect's waxy epicuticular layer
(B) The rapid behavioral evolution of insects to strictly hold their breath for weeks
(C) The sudden development of an entirely new, entirely anaerobic respiratory pathway
(D) Mutations in the DLD enzyme which reduce the toxic oxidative stress caused by gas

2007

136. The standardized FAO protocol for detecting and monitoring phosphine resistance in field populations of storage pests primarily relies on:
(A) Exposing adult insects to a fixed discriminating dose of phosphine gas for a specific duration and recording knockdown/mortality
(B) Visually inspecting the structural integrity

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of the insects' mandibles under an electron microscope
(C) Feeding the insects highly toxic baits and measuring the time to death
(D) Sequestering the insects in a pure oxygen environment and analyzing their respiration rate

2025

137. Identify the correct pair linking the concept of resistance with its precise definition in the context of storage entomology.
(A) Behavioral resistance - The mutation of target-site enzymes preventing chemical binding
(B) Cross-resistance - Survival via a mechanism developed against related chemicals
(C) Passive resistance - The insect entirely stopping the intake of air when it detects a chemical odor
(D) Multiple resistance - Resistance acquired strictly through a single gene mutation affecting only one chemical class

2022

138. Based on the fundamental mechanics of fumigation, infer why "active resistance" to phosphine is significantly more problematic for warehouse managers than purely behavioral avoidance.
(A) Active resistance indicates the insects have physically grown wings and can fly away faster
(B) Resistance implies physiological tolerance, demanding increased dosages for control
(C) Active resistance means the insects actively produce an enzyme that neutralizes phosphine in the air before it reaches the stack
(D) Active resistance only affects the immediate offspring, naturally diluting over time

2005

139. When comparing cross-resistance and multiple resistance in a highly problematic strain of Tribolium castaneum, what distinguishes multiple resistance?
(A) The strain possesses independent mechanisms to survive unrelated chemical classes
(B) The strain resists all pyrethroids via a single knockdown resistance (kdr) mutation
(C) The strain exhibits resistance in the larval stage but high susceptibility in the adult stage
(D) The strain survives strictly by hiding deep inside the grain kernel where chemicals cannot reach

2001

140. Read the following lists regarding resistance mitigation strategies and their principles:
List I: (Strategy)
P. Chemical rotation
Q. Strict gas-tight tarping
R. Increased exposure period
S. Integration of physical controls (e.g., heat/MAS)
List II: (Principle)
1. Eliminates the selection pressure of purely sublethal chemical doses by ensuring high, lethal CT products
2. Alternates the mode of action to prevent the fixation of a single resistance gene in the population
3. Provides a non-chemical lethal mechanism to eliminate highly chemically resistant individuals
4. Overcomes the reduced respiratory uptake typical in strongly resistant phenotypes by allowing more time for gas accumulation
Match the following:
(A) P-2, Q-1, R-4, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-4, R-2, S-1
(D) P-2, Q-3, R-1, S-4

2018

141. What is the precise biological cause and effect of consistently "under-dosing" a warehouse stack during repeated fumigation cycles?
(A) It causes the complete spontaneous eradication of all pests by starving them slowly
(B) It forces the insects to enter a permanent state of protective diapause, causing zero grain damage
(C) It immediately renders the grain chemically toxic, permanently preventing further infestation
(D) It kills susceptible pests while allowing tolerant ones to survive and fix resistance

2013

142. The potent insecticidal and chemosterilant properties of Acorus calamus (Sweet flag) rhizome powder against storage pests are primarily attributed to which active biochemical principle?
(A) Azadirachtin
(B) Pyrethrin I

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(D) To ensure all grain is transported fully submerged in liquid nitrogen

2003

157. Identify the INCORRECT pair linking the concept of Action Thresholds in storage IPM with its practical application.

(A) Economic threshold - The pest density at which management interventions should be initiated to prevent the population from reaching the economic injury level

(B) Seed viability threshold - Extremely low tolerance due to the high value and required germinability of the stored commodity

(C) Quarantine threshold - Absolute zero tolerance for heavily regulated, invasive exotic pests

(D) Zero tolerance threshold - Typically applied strictly to secondary feeders in grain destined for livestock feed

2018

158. In designing an Integrated Pest Management (IPM) program for a storage godown, why is the strict integration of structural sanitation considered the foundational prerequisite before releasing any biological control agents?

(A) Because biological agents are completely incapable of surviving in clean environments

(B) Because sanitation instantly kills all the parasitoids immediately upon release

(C) Because structural debris provides alternative food and refuges for pest populations

(D) Because sweeping the floors directly generates high levels of insecticidal ozone gas

2004

159. In the categorization of stored grain based on visible damage, a sample of wheat containing kernels with distinct, circular emergence holes is definitively characterized as:

(A) Sprouted grain

(B) Weevilled grain

(C) Shriveled grain

(D) Heat-damaged (bin-burnt) grain

2015

160. What is the core philosophical approach that distinguishes Integrated Pest Management (IPM) in storage godowns from traditional, purely chemical-based pest control?

(A) The absolute reliance on exclusively botanical extracts to achieve 100% pest eradication

(B) The routine, calendar-based application of heavy prophylactic sprays and fumigants regardless of actual pest presence

(C) The complete abandonment of all chemical tools in favor of only deploying parasitic wasps

(D) The strategic integration of prevention and monitoring with curative chemical last resorts

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probes intercept movement in the bulk
(C) Pitfall traps are exclusively placed outside the godown perimeter, while probe traps are placed on the roof
(D) Pitfall traps only capture flying moths, while probe traps only capture flightless beetles

2024

150. Identify the correct statement detailing the utility of pheromone lures in a warehouse Integrated Pest Management (IPM) program.
(A) Pheromone lures immediately and permanently eradicate entire insect populations without any further intervention required
(B) Pheromone lures emit broad-spectrum toxic gases that kill all arthropod life within a 10-meter radius
(C) Pheromones provide species-specific early detection long before visible grain damage
(D) Pheromone lures are completely ineffective for detecting cryptic pests like the Khapra beetle

2017

151. What is the fundamental mechanism by which a perforated plastic probe trap successfully captures insects deep within a grain bulk?
(A) It generates a massive magnetic field that pulls the insects through the perforations
(B) It releases extremely high heat, causing the insects to rush toward the cool plastic
(C) It physically grabs the insects using highly automated micro-robotic arms
(D) Migrating insects encounter perforations and fall into a tube they cannot climb out of

2015

152. Which demonstrates an elimination-based flaw in relying entirely on visual surface inspection to declare a bulk silo "pest-free"?
(A) Visual inspection fails at low densities as most pests are hidden inside the bulk
(B) Visual inspection causes the grain to spontaneously overheat and combust
(C) The light from the inspection flashlights instantly kills all primary feeders
(D) Visual inspection physically damages the grain pericarp, making it vulnerable to immediate fungal attack

2021

153. In calculating the absolute sampling intensity for a large stack of bagged grain (e.g., $n > 100$ bags), if a warehouse manager uses the standard square root formula, and the stack contains exactly 400 bags, how many bags must be individually sampled?
(A) 4 bags
(B) 10 bags
(C) 20 bags
(D) 40 bags

2009

154. What critical inference must a warehouse manager draw if pheromone trap catches show a sudden, exponential spike in Tribolium castaneum adults, yet random probe sampling of the grain yields very few insects?
(A) The pheromone lure is defective and actively creating new insects out of dust
(B) Adults are wandering or cross-infesting but haven't established deep in the bulk
(C) The entire grain bulk is already structurally destroyed and completely unsalvageable
(D) The insects have mutated to become completely immune to all known chemical pesticides

2016

155. Consider the following statements regarding standard inspection protocols and grading of stored food grains:
I. "Clear" grading indicates zero live insects found per kilogram of the sampled grain.
II. "Few" grading indicates a moderate but acceptable infestation usually requiring immediate aeration only.
III. "Heavy" grading typically mandates immediate curative chemical intervention (fumigation).
IV. "Weevilled grain" strictly refers only to grain damaged by rodents.
Which of the above statements are correct?
(A) I and III
(B) I, II and III
(C) II and IV
(D) I and IV

2003

156. Under the regulations of the Destructive Insects and Pests (DIP) Act, what is the primary function of domestic quarantine checkpoints for agricultural commodities?
(A) To randomly confiscate and destroy perfectly healthy grain to manipulate market pricing
(B) To mandate that all transport vehicles are painted with reflective coatings
(C) To inspect moving consignments to prevent the spread of isolated pests into new zones

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because it lacks the ability to penetrate deep into the grain mass. It primarily remains active in the headspace and surface layers, leaving pests in the center unaffected.

46. (C) Extracting samples from distinct depths of a bulk to assess localized infestation
A compartmentalized grain trier is a specialized sampling tool consisting of an outer tube with multiple slots and an inner rotating tube. When inserted into a grain bulk, the compartments can be opened at specific depths to collect representative samples. This allows warehouse managers to accurately assess the grain quality and detect localized insect infestations at different vertical strata.

47. (B) Using CAP storage for the indefinite multi-year storage of highly hygroscopic milled flours
Cover and Plinth storage is intended as a temporary or buffer solution for whole cereal grains during periods of peak procurement. It is not suitable for long-term storage or for highly processed and hygroscopic products like milled flour. Such commodities are extremely sensitive to the temperature and moisture fluctuations inherent in outdoor CAP systems, which would lead to rapid spoilage.

48. (D) Pitfalls capture insects on the surface, while probes capture those moving in the bulk
In pest monitoring, pitfall traps and probe traps serve different functions based on their placement. Pitfall traps are typically placed on the surface of the grain or floor to capture wandering adult insects. In contrast, probe traps are perforated tubes inserted deep into the grain bulk to intercept and capture insects as they migrate through the interstitial spaces of the mass.

49. (A) Pest migration from infested lots or structures to uninfested clean grain
Cross-infestation is a major concern in warehouse management, referring to the movement of pests from one source to another. This occurs when insects migrate from heavily infested grain bags, contaminated storage structures, or even old spillage into newly arrived clean grain. Maintaining strict hygiene and physical separation of different lots is essential to prevent the spread of pests throughout the facility.

NODIA

50. (A) P-2, Q-4, R-1, S-3
Grain drying techniques utilize different principles for moisture removal. Deep-bed drying creates a distinct moisture gradient as the drying front moves through the mass. Thin-layer drying exposes individual kernels to air for rapid, uniform moisture loss. Solar drying is traditional but weather-dependent, while forced aeration uses ambient air primarily to cool the grain and equalize moisture rather than for rapid drying.

51. (A) Survives diagnostic doses and requires higher concentrations for mortality
Active resistance to phosphine occurs when a pest population undergoes genetic selection that allows individuals to survive doses that were previously lethal. According to international standards, this is confirmed when insects survive a standardized diagnostic dose. Managing such populations requires significantly higher gas concentrations and longer exposure periods to overcome the physiological mechanisms that the insects have developed to tolerate the fumigant.

52. (D) It induces ice crystallization in cells, leading to mechanical damage and death
Exposure to extreme low temperatures is a highly effective physical control method because it causes the water within the insect's cells and tissues to freeze. The formation of ice crystals results in irreversible mechanical damage to cellular membranes and vital organs. Most storage pests are tropical in origin and lack the physiological adaptations necessary to survive such intense cold, leading to rapid mortality.

53. (B) The liver, leading to hepatocellular carcinoma
Aflatoxin B1 is one of the most potent naturally occurring carcinogens and is primarily produced by Aspergillus flavus. When humans ingest contaminated grain, the toxin is metabolized in the liver into highly reactive intermediates. These compounds can cause acute liver damage and, with chronic exposure, significantly increase the risk of developing hepatocellular carcinoma, especially in individuals with pre-existing liver conditions.

54. (C) To ensure the sample represents a specific stratum rather than a mixed column
Using a compartmentalized probe correctly is vital for accurate grain sampling. Inserting the probe in the closed position prevents it from filling with grain from the upper layers as it

ANSWERS

1. (A) Aerobic respiration of the living grain embryo
Stored cereal grains are living biological entities that continue to undergo aerobic respiration in the presence of oxygen. This metabolic process utilizes the starchy reserves of the embryo and endosperm to generate energy. Significant byproducts of this biochemical pathway include metabolic heat and moisture, which accumulate within the grain bulk and can promote further physiological deterioration.

2. (C) Free water supports microbial growth, while bound water is held by macromolecular forces
Water in grain exists in two distinct forms based on its molecular interaction. Bound water is chemically attached to proteins and carbohydrates, exhibiting low vapor pressure and remaining unavailable for biological use. Conversely, free water moves through intercellular spaces and maintains high vapor pressure, facilitating the enzymatic activity and microbial proliferation that causes storage spoilage.

3. (A) Qualitative degradation is limited to cosmetic changes and does not alter protein solubility
Nutritional depletion in stored grains involves significant chemical transformations that extend far beyond mere visual or cosmetic changes. Prolonged storage, especially under poor conditions, leads to the degradation of essential proteins and a marked decrease in their solubility. These biochemical changes negatively impact the functional properties of the grain, making it less suitable for milling and processing.

4. (B) Quantitative weight loss due to internal insect feeding
The Count and Weigh method is a standardized entomological procedure used to quantify the physical mass lost during storage. By comparing the weight of a specific number of insect-damaged kernels against the same number of healthy kernels, researchers can calculate the percentage of weight lost. This technique is particularly effective for assessing damage from primary internal feeders.

5. (C) II and III
Grain physiology is highly sensitive to environmental factors. An increase in moisture content triggers an exponential rise in the respiration rate of the kernels. Concurrently, biochemical degradation processes, often accelerated by fungal and insect activity, lead to the breakdown of lipids. This results in a measurable increase in fat acidity, which serves as a reliable indicator of deterioration.

6. (C) Convection currents drive warm, moist air which then condenses in the cooler regions of the bulk
Moisture migration in large grain bulks is primarily driven by temperature differentials between the center and the exterior. As warm air rises through the center of the mass via convection, it carries evaporated moisture. When this moist air reaches the cooler surface or walls of the silo, it reaches the dew point and condenses, creating high-moisture pockets.

7. (D) Interstitial grain temperature
Among various abiotic factors, the temperature of the air within the grain interstices is the most critical driver for insect population dynamics. Most major storage pests are poikilothermic, meaning their metabolic rates and reproductive cycles are directly regulated by external warmth. Optimal temperatures facilitate rapid life cycles, while extreme heat or cold can effectively halt their multiplication and survival.

8. (A) Desorption grains equilibrate at a higher moisture content than adsorption grains at same RH
The hysteresis effect describes the path-dependent nature of the equilibrium moisture content in biological materials. For a given relative humidity, grain that is drying (desorption) will retain a slightly higher moisture content than grain that is gaining moisture (adsorption). Understanding this difference is practically significant for warehouse managers when calculating safe storage limits and predicting grain behavior during aeration.

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(C) Beta-asarone
(D) Rotenone

2023

143. In the application of biological control within grain godowns, the predatory bug Xylocoris flavipes is conceptually most effective when used:
(A) To control deep-seated, primary internal infestations inside massive bulk silos
(B) As a surface predator targeting eggs and early larvae of external feeders and moths
(C) Strictly to hunt down and completely eradicate mature, actively gnawing rodent populations
(D) To actively consume and neutralize toxic aflatoxins produced by fungi

2015

144. Identify the INCORRECT statement regarding the application of Neem (Azadirachta indica) derivatives as botanical protectants in storage.
(A) Azadirachtin functions potently as an antifeedant, causing larvae to cease feeding
(B) Neem derivatives interfere with the insect endocrine system, specifically acting as insect growth regulators (IGRs) that disrupt molting
(C) Traditional admixture of neem leaves to stored grain generally reduces initial pest multiplication without leaving toxic synthetic residues
(D) Neem formulations act immediately as powerful nerve poisons, knocking down flying insects in seconds

2008

145. Consider the following statements regarding the limitations of implementing biological control in commercial grain godowns:
I. Parasitoid populations generally lag behind the explosive reproductive rates of the storage pests.
II. The presence of significant numbers of live parasitoid insects inside the food grain is legally and aesthetically unacceptable to most consumers.
III. Frequent prophylactic applications of broad-spectrum contact insecticides in godowns severely disrupt parasitoid establishment.
IV. Parasitoids can completely reverse the quantitative loss already inflicted upon the grain kernel.
V. Biological control agents strictly require high concentrations of carbon dioxide to hunt effectively.

Which of the above statements are correct?
(A) II, III and V
(B) I, II and IV
(C) I, II and III
(D) III, IV and V

NODIA

2025

146. Which specific life stage of the rice weevil (Sitophilus oryzae) is primarily targeted by the natural parasitoid wasp Anisopteromalus calandrae?
(A) The actively flying adult stage
(B) The exposed eggs glued to the grain surface
(C) The late-instar larva and pupa hidden inside the grain kernel
(D) The heavily sclerotized mature adult resting in structural crevices

2008

147. Which of the following best describes the generalized mode of action of essential oils (e.g., from eucalyptus or mint) when deployed as botanical fumigants or protectants against storage insects?
(A) They exhibit strong neurotoxicity, often interacting with the octopaminergic system
(B) They act as physical barriers, completely cementing the grain kernels together
(C) They selectively degrade the insect's chitinous exoskeleton without entering the body
(D) They initiate massive, uncontrolled fungal growth that competitively excludes insects

2011

148. A compartmentalized grain trier (or deep bin probe) is structurally defined by which feature that enables its specific sampling function?
(A) A highly sensitive array of microphones used to amplify the sound of feeding larvae
(B) A continuous vacuum motor that blindly sucks grain up through a flexible hose
(C) A heavy lead weight that smashes through the grain to physically crush pests
(D) A tube and casing with slots rotated to open compartments at precise depths

2013

149. When comparing sampling devices used in storage pest monitoring, what operational difference separates pitfall traps from probe traps?
(A) Pitfall traps actively emit heavy fumigant gases, while probe traps emit liquid attractants
(B) Pitfalls catch insects on the surface, while

18. (C) Oryzaephilus surinamensis
The saw-toothed grain beetle is easily identified by its unique thoracic morphology. On each lateral margin of the thorax, there are six sharp, tooth-like projections. This secondary external feeder is commonly found in a wide range of stored products, particularly those that are already broken or processed, where it feeds on grain dust and small particles.

19. (A) It fails to address bird populations already nesting inside the roof trusses
Structural exclusion using netting or mesh is an effective preventative measure to stop new birds from entering a warehouse. However, if a population is already established and nesting within the internal structures, such as the rafters or roof trusses, external netting cannot remove them. This limitation necessitates a combination of exclusion and active removal for comprehensive avian management.

20. (A) P-3, Q-1, R-4, S-2
Storage pests exhibit distinct biological traits that aid in their identification. Sitophilus oryzae has a characteristic rostrum, while Tribolium castaneum produces pinkish flour through chemical secretions. Ephestia cautella larvae are known for creating extensive silken webbing over bagged grain. Trogoderma granarium is notorious for its ability to undergo long periods of diapause in structural cracks during unfavorable conditions.

21. (B) Plodia interpunctella
The Indian meal moth is a major pest of processed foods and milled products. The adult is easily recognized by its distinctive wing coloration, where the inner half is pale gray and the outer portion is coppery-red or bronze. The larvae are notorious for their wandering behavior and the production of dense silken webs that contaminate various stored commodities.

22. (C) A transition from high water activity fungi to those tolerating lower water activity
Microbial succession in storage is defined by changing environmental conditions, particularly moisture levels. Field fungi, such as Fusarium, require very high water activity and typically decline as the grain dries. Storage fungi, predominantly species of Aspergillus and Penicillium, are adapted to the drier conditions of the warehouse, eventually dominating the microflora as the grain reaches equilibrium with storage environments.

23. (D) It metabolizes carbohydrates to generate localized zones of intense heat and moisture
Fungal proliferation, particularly by Aspergillus species, significantly alters the microenvironment of the grain bulk. As these fungi metabolize the grain's carbohydrates, they release energy in the form of heat and moisture as metabolic byproducts. This creates localized "hot spots" where temperatures can rise rapidly, further accelerating both fungal growth and the physiological deterioration of the grain.

24. (A) They are potent neurotoxins responsible for causing equine leukoencephalomalacia in horses
Fumonisins are a group of mycotoxins primarily produced by Fusarium verticillioides in maize. They are of significant veterinary importance due to their specific neurotoxic effects. In horses, ingestion of contaminated grain leads to equine leukoencephalomalacia, a fatal disease characterized by the liquefaction of white matter in the brain. These toxins also pose various health risks to other livestock.

25. (C) I, II and V
Grain deterioration is influenced by several factors. Moisture is the most critical abiotic factor regulating biological activity. Furthermore, the respiration of fungi within the bulk releases metabolic water, which can artificially increase local moisture levels. Temperature gradients within the storage structure are also essential, as they trigger convection currents that drive moisture migration from warm to cool zones.

26. (B) Fusarium
Fungal genera are categorized based on their moisture requirements. Fusarium is classified as a field fungus because it requires a high water activity, typically above 0.90, to grow and reproduce. In contrast, storage fungi like Aspergillus and Wallemia are xerophilic, meaning they are adapted to the relatively low moisture conditions and lower water activity found in dry stored grains.

27. (A) Bodies and cast skins of storage mites such as Tyrophagus putrescentiae
Grocer's itch is a form of allergic contact dermatitis that affects individuals handling infested commodities. This condition is caused

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by a hypersensitivity reaction to the proteins found in the bodies, cast skins, and fecal matter of storage mites. These microscopic arachnids thrive in damp grain and flour, and their debris can become airborne or contaminate surfaces during grain handling.

28. (C) It excavates burrow systems to transport large volumes of grain underground
The lesser bandicoot rat causes massive quantitative losses through its unique hoarding behavior. Beyond what it consumes, this rodent actively transports large quantities of grain from the storage area into its extensive underground burrow systems. These hidden caches can contain several kilograms of grain, making the total loss much higher than the amount actually eaten by the pest.

29. (D) Rattus rattus is entirely incapable of scaling vertical walls, limiting its damage strictly to floor-level stacks
The black rat, also known as the roof rat, is exceptionally agile and possesses superior climbing abilities. It can easily scale vertical walls, pipes, and cables to reach elevated areas of a warehouse. This behavior allows it to nest in roof trusses and attack grain stacks from the top, contradicting the idea that its damage is limited to the floor.

30. (C) Dead birds falling into the bulk cause biological contamination and foul odors
Using acute toxic baits for avian control inside a food warehouse is highly discouraged due to the risk of secondary contamination. Birds that ingest the poison may die while perched above the grain stacks. Their carcasses, along with feathers and droppings, fall directly into the commodity, leading to serious biological hazards, foul odors, and making the grain unfit for consumption.

31. (B) Heated air increases the vapor pressure gradient to facilitate moisture transfer
Mechanical drying relies on the principle of vapor pressure differentials. By passing heated air through the grain bulk, the temperature of the kernels increases, which in turn raises the vapor pressure of the moisture inside the grain. This creates a steep gradient between the grain and the relatively drier air, forcing the moisture to evaporate and be carried away.

NODIA

32. (D) It features a polythene sheet between mud layers to provide a moisture barrier
The Pusa bin is an improved version of the traditional earthen storage structure. Its primary innovation is the inclusion of a thin polyethylene sheet sandwiched between two layers of mud-brick walls. This plastic layer acts as a highly effective moisture and gas barrier, significantly reducing the entry of atmospheric humidity and improving the overall airtightness of the structure.

33. (A) Concrete silos provide superior insulation, reducing fluctuations and condensation
In modern bulk storage, concrete silos offer a distinct thermal advantage over metal silos. The thick concrete walls provide excellent insulation, which minimizes the impact of external diurnal temperature fluctuations on the stored grain. This stability helps prevent the development of temperature gradients within the bulk, thereby reducing the risk of convection-driven moisture migration and subsequent condensation.

34. (C) To ensure ventilation, permit inspection, and facilitate spraying or tarping
Maintaining standardized alleyways between grain stacks and warehouse walls is a fundamental requirement of scientific management. These clear spaces allow personnel to move freely for regular inspections, facilitate the circulation of air to prevent heat buildup, and provide the necessary room for performing essential pest control tasks, such as applying prophylactic sprays or securing covers for fumigation.

35. (B) I, III and IV
Rhyzopertha dominica, the lesser grain borer, is a highly destructive primary feeder. Both the adult beetles and the larvae possess strong mandibles that allow them to attack sound, whole kernels. Infestations are characterized by a distinct sweetish odor and the accumulation of large amounts of fine, powdery frass. Contrary to some beliefs, the adults are strong flyers and disperse easily.

36. (D) Caryedon serratus - Groundnut pods and tamarind seeds
Caryedon serratus is a specialized bruchid beetle that is a major pest of unshelled groundnuts and tamarind seeds. While most other bruchids target pulses, this species has adapted to penetrate the tougher outer coverings of these specific hosts.

It is frequently found in storage facilities where these commodities are held before processing, causing significant internal damage to the seeds.

37. (B) MAS requires extended exposure times to achieve mortality via lethal hypoxia
Modified Atmosphere Storage operates by altering the concentrations of oxygen and carbon dioxide to create a lethal environment for pests. Unlike chemical fumigants that can kill relatively quickly, MAS relies on the gradual physiological exhaustion and hypoxia of the insects. This process often requires several days or even weeks of continuous exposure to ensure a complete kill of all stages.

38. (C) Wooden crates overlaid with a polythene sheet or specialized mats
Effective dunnage is essential to prevent moisture from the warehouse floor from seeping into the bottom layers of grain bags. The most recommended system involves using wooden crates to elevate the stack, providing an air gap. This is typically combined with a heavy-duty polythene sheet or moisture-proof mats to create a complete barrier against capillary action and ground vapors.

39. (D) Their hermetic design causes oxygen depletion to asphyxiate the insects
Purdue Improved Crop Storage bags utilize a triple-layer hermetic sealing technology to protect pulses from bruchids. The two inner polyethylene liners are tied tightly, creating an airtight environment. As insects and the grain itself respire, they consume the available oxygen and release carbon dioxide. The resulting hypoxia and hypercarbia eventually halt insect development and cause death through asphyxiation.

40. (A) Both A and R are true and R is the correct explanation of A.
Callosobruchus species are notorious for initiating infestations in the field. The adult beetles are active flyers that migrate to maturing pulse crops, where they deposit eggs directly onto the developing pods. The larvae then bore into the seeds. When the crop is harvested and moved into storage, these hidden life stages continue their development, leading to rapid population growth.

NODIA

41. (B) 3 liters per 100 square meters
For effective prophylactic surface treatment of warehouse walls and floors, a standardized application rate is followed. Using a diluted solution of an approved insecticide like malathion, the spray is applied at a rate of three liters for every one hundred square meters of surface area. This ensures uniform coverage and a sufficient residual deposit to control crawling insects and prevent cross-infestation.

42. (B) Ammoniation under pressure and high temperature
Ammoniation is a scientifically proven chemical method for the detoxification of aflatoxin-contaminated grains, particularly for animal feed. The process involves exposing the grain to ammonia gas under specific conditions of pressure and temperature. The ammonia reacts with the lactone ring of the aflatoxin molecule, permanently neutralizing its toxicity and making the feed safer for livestock consumption.

43. (A) To ensure gas-tight sealing for maintaining lethal phosphine concentrations
During curative fumigation with phosphine, achieving a perfect seal is paramount. Using mud-plaster or heavy sand-filled tubes (sand-snakes) to weigh down the edges of the fumigation covers prevents the gas from leaking out. This ensures that the lethal concentration of phosphine is maintained throughout the entire exposure period, which is necessary to kill all life stages of the target pests.

44. (C) Enhanced metabolic detoxification of the phosphine molecule via specialized esterases
Resistance to phosphine is a complex genetic trait that does not involve common detoxification enzymes like esterases. Instead, highly resistant insects typically exhibit reduced respiratory uptake of the gas or carry mutations in the dihydrolipoamide dehydrogenase enzyme. Behavioral avoidance, where insects move away from areas with low gas concentrations, also contributes to their survival in poorly sealed or under-dosed environments.

45. (D) It restricts its predatory activity to the surface layers of the mass
Xylocoris flavipes, known as the warehouse pirate bug, is a generalist predator that feeds on the eggs and larvae of many storage pests. However, its effectiveness in large bulk storage is limited

9. (B) It refers to developing insect stages hidden inside the kernels at the time of harvest
Latent infestation is a significant challenge in storage management as it involves insects that are already present within the grain before it enters the warehouse. These pests typically consist of eggs or larvae deposited by adults in the field. Because they are hidden inside sound kernels, they remain undetected during initial inspections, eventually emerging as adults during storage.

10. (A) Both A and R are true and R is the correct explanation of A.
Cereal grains are inherently hygroscopic, meaning they possess a natural affinity for water vapor. The equilibrium moisture content is reached when the vapor pressure of the grain matches that of the surrounding air. Because this exchange is continuous and bidirectional, the moisture level of the grain is always a direct function of the ambient temperature and relative humidity.

11. (A) Trogoderma granarium larvae surviving cold by entering facultative diapause
Most storage insects are highly sensitive to extreme temperatures and cease activity when conditions fall below specific thresholds. However, the Khapra beetle exhibits a unique survival strategy. Its larvae can enter a state of facultative diapause, characterized by a drastically reduced metabolic rate. This allow them to survive in cracks and crevices for extended periods during unfavorable cold or starvation.

12. (C) Primary feeders can penetrate sound, whole kernels to feed and develop internally
Primary internal feeders are characterized by their specialized morphological adaptations, such as powerful mandibles or a rostrum, which allow them to bore into intact, healthy grain kernels. Once inside, the larvae feed on the endosperm or embryo, completing their development within the protected environment of the seed. This distinguishes them from secondary feeders that require pre-damaged grain.

13. (D) Grains hollowed out from within, leaving a translucent "window pane" of pericarp before adult emergence
The Angoumois grain moth causes a highly specific type of damage to stored paddy and maize. The larva feeds entirely within a single kernel, hollowing it out. Before pupation, the larva eats toward the surface but leaves a very thin, translucent layer of the seed coat. This circular "window pane" remains intact until the adult moth pushes through.

14. (C) Non-lipid fractions concentrate internal moisture, raising the local water activity
Oilseeds contain a high percentage of hydrophobic lipids that do not absorb water. Consequently, all the moisture in an oilseed is concentrated within the smaller non-lipid fraction, such as proteins and carbohydrates. This leads to a much higher water activity at a given moisture percentage compared to cereals, necessitating a lower overall moisture threshold for safe storage.

15. (B) Count 1000 grains from sample → Separate damaged and undamaged grains → Weigh both fractions → Calculate percentage loss using standardized formula
The Thousand Kernel Weight method provides a reliable estimate of quantitative loss by comparing the mass of damaged and healthy grains. The process begins with counting a standardized sample. By separating the infested kernels and weighing both groups separately, the relative weight reduction can be accurately determined. This value is then used to extrapolate the total loss within the lot.

16. (D) Caryedon serratus - Primarily attacks milled cereal flours and highly processed spices
The species Caryedon serratus is unique among storage beetles because it primarily infests groundnut pods and tamarind seeds rather than milled cereal products. It is the only member of the bruchid family that can successfully develop within the thickened hulls of these commodities. This distinct host preference makes it a major concern in specific agricultural processing and export sectors.

17. (A) Attack whole and broken grains with adults and larvae boring into the kernels
The lesser grain borer is exceptionally destructive because both the adult beetles and their larvae possess powerful mouthparts capable of boring into sound kernels. Unlike many other pests where only the larval stage causes significant internal damage, the adults of this species are active feeders. Their boring activity produces large amounts of fine floury frass and reduces grain to shells.

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descends. By opening the compartments only at the desired depth, the operator ensures that the collected sample truly represents the grain quality and infestation status of that specific vertical layer.

55. (D) Egg deposition → Active larval feeding → Facultative diapause deep in crevices → Pupation → Short-lived adult emergence
The life cycle of Trogoderma granarium is uniquely adapted to challenging environments. After eggs are laid, the larvae undergo several molts while feeding voraciously. If conditions become unfavorable, they can enter a prolonged facultative diapause, hiding deep within structural cracks. Once conditions improve, they complete pupation and emerge as short-lived adults whose primary purpose is to mate and lay eggs.

56. (A) Cryptolestes ferrugineus
Primary internal feeders are those insects that can attack and develop inside whole, sound grain kernels. This group includes Sitophilus species and Rhyzopertha dominica. In contrast, Cryptolestes ferrugineus, the rusty grain beetle, is classified as a secondary external feeder. It generally requires broken kernels or grain dust to feed and cannot initiate an infestation within perfectly intact, sound seeds.

57. (B) Inducing reproductive sterility or somatic death by damaging insect cellular DNA
Ionizing radiation, such as Gamma rays, is a highly effective physical disinfestation method. The high-energy waves penetrate the grain and the insects within it, causing extensive damage to their cellular DNA. At lower doses, this induces reproductive sterility in the adults, preventing further multiplication. At higher doses, it causes direct somatic death of all life stages without leaving any chemical residues.

58. (B) Its active principle, beta-asarone, exhibits strong contact toxicity and anti-gonadal properties
Acorus calamus, commonly known as sweet flag, is a traditional botanical protectant. Its rhizomes contain an active biochemical compound called beta-asarone. This principle exerts its effect on storage pests through both contact toxicity and unique anti-gonadal properties. It can cause permanent sterility in adult insects, thereby halting their reproductive cycle and effectively managing the population within the stored commodity.

59. (A) The highest concentration of a pesticide legally permitted in or on food commodities, considered safe for human consumption
The Maximum Residue Limit is a critical food safety standard established by regulatory bodies. It defines the maximum concentration of a pesticide residue that is legally allowed to remain on food products after treatment. These limits are set based on extensive toxicological data to ensure that the consumption of treated grains poses no health risk to humans over a lifetime of exposure.

60. (C) Phosphine gas is completely non-flammable and poses zero risk of auto-ignition regardless of its concentration in the air
Phosphine is a highly effective but hazardous fumigant. It is reactive and, in its pure form, can be spontaneously flammable in air if the concentration exceeds its lower flammability limit of 1.79% by volume. For this reason, commercial aluminium phosphide formulations include additives like ammonium carbamate, which release ammonia and carbon dioxide to help suppress the risk of ignition and explosion.

NODIA

61. (B) Multiple resistance occurs when independent mechanisms confer resistance to distinct insecticide classes, whereas cross-resistance involves a single mechanism conferring resistance to related insecticides
In storage entomology, resistance is categorized by its underlying genetic and biochemical basis. Cross-resistance happens when a single physiological mechanism, such as a target-site mutation, provides protection against multiple chemicals in the same class. Multiple resistance is more complex, occurring when a pest population has evolved several different, independent mechanisms that allow it to survive exposure to entirely unrelated classes of insecticides.

62. (C) They are species-specific and can detect pests at very low densities before damage
Pheromone lures are highly sensitive tools for the early detection of storage pests. By utilizing the specific sex or aggregation pheromones of a target species, these traps can capture insects even when their population density is extremely low. This allows warehouse managers to identify an infestation and initiate control measures long

atmosphere into the grain. Furthermore, these structures are vulnerable to rodents, who can easily gnaw through the dried mud to access the grain. They also lack the airtightness necessary for effective chemical fumigation against insects.

99. (A) It acts as a physical barrier preventing grain from absorbing moisture vapor
The Pusa bin incorporates a polyethylene sheet within its mud-brick walls to solve the problem of moisture transmission. This plastic layer serves as a vapor barrier, preventing atmospheric humidity from being absorbed through the porous mud and reaching the stored grain. This improvement helps maintain a lower, more stable grain moisture content, thereby reducing the risks of fungal growth and insect multiplication.

100. (A) Both A and R are true and R is the correct explanation of A.
Traditional mud bins are often ineffective during humid periods like the monsoon. The earthen material used in their construction is naturally porous and hygroscopic. This allows atmospheric moisture to penetrate through the walls and into the grain bulk, raising the moisture content to levels that promote rapid fungal growth and grain spoilage, especially if the structure is not properly sealed.

101. (B) They are susceptible to rodents, cross-infestation, and lack gas-tightness
Traditional rural storage structures, such as unlined bamboo bins or simple Morais, have several structural demerits. They offer little protection against rodents, who can easily penetrate the walls. Furthermore, their open or porous construction allows for easy cross-infestation by insects and makes it impossible to achieve the gas-tight seal required for effective curative fumigation, leading to high losses over the storage period.

102. (C) To displace interstitial oxygen before pests enter protective metabolic torpor
When using carbon dioxide for Modified Atmosphere Storage, a high initial purge rate is essential. The goal is to rapidly lower the oxygen concentration throughout the entire grain mass. If the oxygen levels drop too slowly, some insects may be able to adjust their metabolism and enter a state of torpor, which can significantly increase the time required to achieve total mortality.

103. (D) Temperature gradients leading to convection, moisture migration, and sweating
Corrugated metal silos are highly conductive to heat, leading to significant temperature fluctuations within the grain mass near the walls. These temperature gradients trigger convection currents where warm air rises and carries moisture to cooler areas. This process results in moisture migration and the condensation of water on the roof and upper layers of the grain, often referred to as "sweating."

104. (A) Large-scale transit and buffer storage of bagged cereal grains during overflow
Cover and Plinth storage is a logistical solution used extensively in India to handle surges in grain procurement. It involves stacking bagged grain on elevated brick platforms in the open and covering them with heavy-duty waterproof tarpaulins. This system is primarily intended for short-term or buffer storage when permanent warehouse capacity is exceeded, particularly for cereal grains like wheat and paddy.

105. (B) Intake hopper → Bucket elevator → Upper conveyor → Distributor/Spout → Silo bin
The loading of grain into a modern bulk silo follows a specific mechanical sequence. Grain is first unloaded into an intake hopper, from where it is lifted vertically by a bucket elevator. It then travels along an upper conveyor to a distributor or spout, which directs the grain into the desired silo bin. This automated system allows for the rapid and efficient handling of large volumes.

106. (B) Sweep auger - Clears residual grain in flat-bottom silos to the central discharge
In flat-bottomed bulk silos, grain is typically discharged through a central opening. However, once the grain stops flowing by gravity, a significant amount remains on the floor. A sweep auger is a mechanical device that rotates around the silo floor, pushing this residual grain toward the central discharge point to ensure the silo is completely emptied for cleaning and maintenance.

107. (A) It provides permanent protection against all avian pests and rodent tunneling
While Cover and Plinth storage is highly economical and flexible, it does not provide permanent or absolute protection against all pests. Because it is an outdoor system, the grain stacks remain vulnerable to rodent tunneling

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larva as it feeds inside a grain kernel. These cues allow the wasp to accurately pinpoint the hidden host through the seed coat before depositing its egg.

72. (A) They wander extensively and secrete copious silk, often webbing the surface heavily
The larvae of the Indian meal moth are known for their high mobility within stored products. As they move through the commodity, they continuously produce silken threads. In heavy infestations, this leads to the formation of dense mats of webbing on the surface of bagged or bulk grain. This webbing not only contaminates the food but also traps frass and complicates grain handling.

73. (B) Primary thresholds are near zero as they destroy embryos and cause hidden loss
In storage management, action thresholds for primary internal feeders are set much lower than those for secondary feeders. This is because primary feeders cause irreversible damage by consuming the grain embryo and endosperm from within. Furthermore, because their early stages are hidden inside the kernel, visible symptoms appear only after significant damage has occurred, making immediate intervention necessary even at very low detections.

74. (B) Azadirachtin functions rapidly as a highly lethal contact poison, dropping adult insects instantly upon application
Neem-based products, such as those containing azadirachtin, do not work as rapid knockdown poisons. Instead, they function primarily through complex physiological pathways. They act as potent antifeedants, making the grain unpalatable, and as insect growth regulators that disrupt molting and reproduction. While highly effective over time, they require several days to manifest their lethal effects on a pest population.

75. (A) Sample the square root of the total number of bags in the lot
To obtain a statistically representative sample from a large lot of bagged grain, warehouse managers often use the square root rule. This guideline suggests that the number of bags to be sampled should be equal to the square root of the total number of bags in the stack. This method balances the need for accuracy with practical logistical constraints during inspection.

76. (C) Survival of tolerant individuals, leading to genetic selection for resistance
Under-dosing during fumigation is a major cause of the development of insecticide resistance. When a sub-lethal concentration of phosphine is applied, it may kill the most susceptible individuals but allow those with slightly higher tolerance to survive. These surviving insects then reproduce, passing on their tolerant traits to the next generation, eventually leading to a population that is significantly resistant to the chemical.

77. (D) Mites typically possess four pairs of legs and lack antennae, whereas insects possess three pairs of legs and one pair of antennae
Storage mites are arachnids, which distinguishes them morphologically from storage insects. While adult insects have three pairs of legs and a pair of antennae, adult mites possess four pairs of legs and entirely lack antennae. Additionally, mites are microscopic in size and do not have wings, whereas many storage insects are visible to the naked eye and can fly as adults.

78. (C) Morai
The Morai is a traditional rural storage structure commonly found in parts of eastern and southern India. It is usually an outdoor, circular receptacle built on an elevated platform to protect against moisture and rodents. Constructed from plant materials like bamboo, straw, or reeds, it is predominantly used for the bulk storage of unthreshed paddy before it is processed.

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79. (B) The flour acquires a pungent odor and turns pinkish due to benzoquinone secretion
Severe infestations of Tribolium castaneum cause a specific type of qualitative degradation in flour and grain. The beetles secrete defensive chemicals called benzoquinones from specialized glands. These compounds impart a distinct, pungent, and unpleasant odor to the commodity. Furthermore, the secretions react with the grain proteins, causing the flour to acquire a characteristic pinkish or brownish-red discoloration.

80. (B) P-3, Q-1, R-2, S-4
Rodent species found in storage facilities have unique behaviors. Rattus rattus is a skilled climber that prefers nesting in high places. Mus musculus is characterized by its small home range and erratic nibbling of grain. Bandicota

116. (D) A lethal accumulation of carbon dioxide and depletion of oxygen due to the respiration of grain, insects, and microflora
Hermetic storage relies on the principle of creating a completely airtight environment. Within the sealed container, the natural respiration of the grain kernels, any present insects, and microorganisms consumes the available oxygen and releases carbon dioxide. Because no new air can enter, the oxygen levels drop significantly while carbon dioxide levels rise, creating a lethal atmosphere that eventually halts all biological activity and pests.

117. (B) Two HDPE inner layers enclosed in a protective outer woven polypropylene sack
The Purdue Improved Crop Storage (PICS) bag is a triple-layer technology designed for smallholder farmers. It consists of two inner liners made of high-density polyethylene (HDPE), which provide the necessary hermetic seal. These liners are then placed inside a third, outer bag made of woven polypropylene, which provides the physical strength and durability needed to protect the contents during handling and storage.

118. (C) CAS actively regulates gas concentrations (e.g. N_2 or CO_2) at predetermined levels
Controlled Atmosphere Storage is a sophisticated storage technique where the concentrations of gases like oxygen, nitrogen, and carbon dioxide are actively monitored and maintained at specific levels by mechanical systems. This distinguishes it from Modified Atmosphere Storage, where the gas levels are initially adjusted or naturally changed but are not continuously regulated by an external control system throughout the entire storage period.

119. (D) It causes reproductive sterility or mortality without leaving chemical residues
Ionizing radiation is a powerful tool for grain disinfestation. By exposing the grain to a controlled dose of gamma rays or X-rays, all life stages of insects can be killed or rendered sterile through DNA damage. One of the primary advantages of this method is that it does not involve the use of any chemicals, meaning there are no toxic residues left on the food.

120. (A) Refrigerating thousands of tonnes of grain requires prohibitive energy expenditure
While extreme cold is highly effective at killing storage pests, its use for large-scale bulk storage in tropical or sub-tropical climates is often impractical. The amount of energy required to cool and maintain thousands of tonnes of grain at temperatures below freezing is enormous. This makes refrigeration a much more expensive option compared to other physical or chemical pest control methods like fumigation or aeration.

121. (B) Their spiracles stay open for oxygen, leading to rapid and fatal desiccation
In an environment with very low oxygen levels, insects face a critical physiological challenge. To maximize oxygen intake, they must keep their spiracles, or breathing pores, permanently open. This continuous exposure leads to a massive loss of internal body water through evaporation. Consequently, in hermetic storage, insects often die from rapid and fatal desiccation before they actually succumb to the direct effects of oxygen depletion.

122. (C) 0.5%
Prophylactic surface treatments are used to create a protective barrier against pests. The standard recommendation for spraying the internal surfaces of empty godowns, such as walls and floors, is to use a 0.5% concentration of an approved insecticide like malathion. This concentration is designed to provide effective control of crawling insects while ensuring that chemical residues are kept within safe and acceptable legal limits.

123. (A) Ensuring residual chemical concentration on the commodity remains safe for humans
Adhering to the Maximum Residue Limit is a fundamental principle of food safety when using grain protectants. These limits are carefully calculated to ensure that even if the chemical is applied at the maximum allowed dose, the amount remaining on the grain when it reaches the consumer will be low enough to pose no health risk. This maintains public trust and ensures the grain is marketable.

124. (C) Methyl bromide - Botanical antifeedant
Categorizing pest control agents correctly is essential for safe and effective management. Methyl bromide is a highly effective synthetic chemical fumigant, not a botanical antifeedant.

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lead to the denaturation of vital enzymes and proteins within the embryo. This permanent damage destroys the seed's viability and its capacity to germinate, making it useless for future agricultural planting.

90. (B) The thermodynamic properties of air and water vapor in moisture transfer
Psychrometrics is the scientific study of the physical and thermodynamic properties of gas-vapor mixtures, specifically air and water vapor. In the context of grain drying, understanding psychrometrics is essential for calculating how much moisture the air can absorb at different temperatures and relative humidities. This knowledge allows for the design and operation of efficient mechanical drying and aeration systems.

91. (A) Thin-layer exposes every kernel to drying air, while deep-bed creates zones
The fundamental difference between these two drying methods lies in how the air interacts with the grain. In thin-layer drying, the grain is spread so thinly that all kernels are exposed to the drying air simultaneously. In deep-bed drying, air enters from one side and moves through a thick mass, creating distinct zones of dry, drying, and wet grain as the front progresses.

92. (C) Cool the grain mass uniformly to prevent temperature gradients and condensation
Forced aeration in modern silos is primarily used for temperature management rather than rapid drying. By circulating cool ambient air through the grain bulk during winter, the system helps to maintain a uniform temperature throughout the mass. This prevents the formation of steep temperature gradients, which would otherwise drive moisture migration and lead to damaging condensation at the top of the silo.

93. (D) The development of severe stress cracks, leading to high milling breakage
Rapid drying at high temperatures can cause significant physical damage to grain kernels, particularly paddy. The process creates internal stresses as the outer layers dry and contract much faster than the inner core. This results in the formation of minute "stress cracks" or fissures. When such grain is later milled, it easily shatters, leading to a high percentage of broken kernels and reduced economic value.

94. (C) It relies on unpredictable weather and exposes grain to contamination and pests
Traditional sun drying is a common practice but has several major drawbacks. It is entirely dependent on favorable weather conditions, making it unreliable during the monsoon or on cloudy days. Furthermore, spreading grain in the open exposes it to various contaminants, including dust, bird droppings, and animal feces, as well as to infestation by insects and consumption by various vertebrate pests.

95. (A) I, III and IV
Several factors influence the rate at which grain dries. Higher air velocity generally increases the drying rate by removing the boundary layer of moist air around the kernels. Conversely, lower ambient relative humidity enhances the air's capacity to absorb moisture. The physical characteristics of the grain, such as its shape, size, and initial moisture content, also play a significant role in determining how quickly it dries.

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96. (D) The transitional zone moving with airflow that separates dry grain from wet
In a deep-bed drying system, the "drying front" represents the active region where the most moisture transfer is occurring. As dry air is forced through the bulk, it removes moisture from the grain it first encounters. This creates a zone of dry grain near the air inlet and a zone of wet grain further away, with the drying front acting as the moving boundary between them.

97. (A) Galvanized metal sheets forming a rigid, rat-proof, and relatively airtight container
The PAU bin, developed by Punjab Agricultural University, is a modern improvement for small-scale storage. It is constructed from galvanized iron sheets, which makes it highly durable and completely resistant to rodent tunneling. Its rigid design allows for a relatively airtight seal, which helps in maintaining the quality of the stored grain and makes the structure easier to clean and manage.

98. (C) The traditional mud bin is entirely impervious to rodent attacks and completely prevents moisture ingress from the soil
Traditional earthen storage structures, while economical, have significant limitations. Mud walls are porous and cannot prevent the transmission of moisture from the ground or the

is the maximum concentration of the gas that a worker can be exposed to over a standard eight-hour workday without adverse health effects. For phosphine, this limit is set at a very low level of 0.3 parts per million, necessitating the use of specialized detection equipment.

134. (C) Fumigating at cold temperatures (below 5°C) where insect metabolic rates are depressed
The effectiveness of phosphine fumigation is highly dependent on temperature. Because the gas works by disrupting the insect's metabolism and respiration, it is most effective when the pests are active. At very low temperatures, insects enter a state of dormancy or depressed metabolism, taking in very little gas. This significantly reduces the biological efficacy of the treatment, even if high concentrations of phosphine are present.

135. (D) Mutations in the DLD enzyme which reduce the toxic oxidative stress caused by gas
Genetic research has identified that high-level resistance to phosphine in several major storage pests is linked to mutations in the dihydrolipoamide dehydrogenase enzyme. This enzyme is a core component of mitochondrial metabolism. The mutations allow the insects to better manage the oxidative stress and cellular damage caused by the gas, enabling them to survive doses that would be lethal to susceptible populations.

136. (A) Exposing adult insects to a fixed discriminating dose of phosphine gas for a specific duration and recording knockdown/mortality
The FAO has established a standardized protocol for monitoring insecticide resistance in the field. This involves collecting insects from a storage facility and exposing them to a specific "discriminating dose" of phosphine gas under controlled conditions. By recording the percentage of insects that survive this treatment, researchers can determine the presence and level of resistance within the population, allowing for better management decisions.

137. (B) Cross-resistance - Survival via a mechanism developed against related chemicals
Cross-resistance is a critical concept in pest management. It occurs when an insect population develops a resistance mechanism, such as a modified target-site enzyme, that provides protection against multiple insecticides within the same chemical class. This means that if a population becomes resistant to one organophosphate, it may also be resistant to others, even if it has never been directly exposed to them.

138. (B) Resistance implies physiological tolerance, demanding increased dosages for control
Active physiological resistance is more challenging to manage than simple behavioral avoidance. While behavioral avoidance can often be overcome through better sealing and coverage, physiological resistance means the insects can actually survive within the toxic environment. This necessitates the use of significantly higher dosages and longer exposure periods, which increases the cost of control and the risk of further selecting for even higher levels of resistance.

139. (A) The strain possesses independent mechanisms to survive unrelated chemical classes
Multiple resistance represents a significant challenge in pest control. It occurs when a single pest population has evolved several distinct and independent mechanisms that allow it to tolerate chemicals from entirely different classes, such as organophosphates and pyrethroids. This makes the population much harder to manage, as rotating between different types of insecticides may not be effective in overcoming the resistance.

140. (A) P-2, Q-1, R-4, S-3
Managing insecticide resistance requires several integrated strategies. Rotating between different chemical classes helps prevent any one resistance gene from becoming fixed in the population. Ensuring gas-tight seals and increasing exposure periods can help overcome the reduced gas uptake often found in resistant insects. Finally, integrating physical controls like heat or modified atmospheres provides a non-chemical way to eliminate highly resistant individuals from the warehouse.

141. (D) It kills susceptible pests while allowing tolerant ones to survive and fix resistance
Consistently applying a dosage of fumigant that is lower than the recommended lethal level is a dangerous practice. This under-dosing creates a powerful selection pressure where the weakest, most susceptible insects are killed, but those with any level of natural tolerance survive and reproduce. Over time, this leads to a population

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through the ground and to damage from birds if the covers are not perfectly maintained. It is best used as a temporary solution rather than for long-term strategic storage.

108. (C) Warm air rising from the bulk center contacts the cold roof and releases water
Headspace sweating is a common problem in metal silos during cold weather. As the exterior of the silo cools, the air near the roof also becomes cold. Meanwhile, warm, moist air continues to rise from the center of the grain bulk through convection. When this warm air meets the cold roof, its moisture capacity drops, leading to the condensation of liquid water onto the grain.

109. (D) Activating aeration fans to draw cool air and dissipate heat to equalize temperature
When a localized "hot spot" is detected in a bulk silo, it indicates active biological activity from insects or fungi. The most effective immediate response is to use the silo's aeration system. By forcing cool ambient air through the mass, the excess heat is dissipated, and the temperature is equalized. This process also helps to slow down the metabolic rates of the organisms causing the heat.

110. (C) P-4, Q-3, R-1, S-2
Scientific bag storage involves several key practices. Block stacking uses interlocking layers to ensure the structural stability of the stack. Dunnage refers to the moisture-proof materials placed on the floor to protect the bottom bags. Alleyways are the essential clear spaces maintained for inspection and airflow, while tarping is the process of covering a stack for fumigation with a gas-proof sheet.

111. (B) 5,000 Metric Tonnes (MT)
Standard modern godown compartments are designed with specific dimensions to hold a fixed amount of bagged grain. A typical compartment, often measuring approximately 125 feet by 70 feet, is rated for a storage capacity of 5,000 metric tonnes. This standardization allows for efficient logistical planning, inventory management, and the implementation of uniform pest control and maintenance protocols across large warehouse complexes.

112. (D) Alleyways are intentionally filled with loose, heavily infested grain to act as a trap for migrating insects
Alleyways are a critical feature of a well-managed warehouse and must be kept clean and clear at all times. They are not used as traps for insects; in fact, any loose grain in the alleyways must be immediately removed to prevent it from becoming a breeding ground for pests. Their primary roles are to facilitate regular inspection, allow for proper ventilation, and provide space for pest control activities.

113. (A) Loose, damp straw or unprocessed agricultural chaff
Using loose straw or agricultural chaff as dunnage is strictly prohibited in scientific warehouses. These materials are highly hygroscopic and can easily absorb and hold moisture from the ground, which then transfers to the grain bags. Furthermore, straw provides an ideal habitat and hiding place for various insect pests and rodents, making it a major sanitation hazard that compromises the safety of the stored grain.

114. (C) By alternating bag orientation in successive layers to create a bonded structure
The stability of a high bag stack is achieved through the use of an interlocking or "block" pattern. In this method, the orientation of the bags is changed between each successive layer. For example, if bags are laid lengthwise in one layer, they are laid crosswise in the next. This creates a bonded structure similar to bricklaying, which prevents the stack from shifting or collapsing.

115. (A) Clean floor → Apply prophylactic wall spray → Lay moisture-proof dunnage → Build stack using interlocking pattern → Maintain required alleyways
Establishing a new grain stack requires a logical sequence of sanitation and logistical steps. The process begins with thoroughly cleaning the area and applying a prophylactic insecticide spray to the walls and floor. Next, moisture-proof dunnage is laid to protect the bags from ground moisture. The stack is then carefully built using an interlocking pattern, while ensuring that the necessary alleyways are maintained for future access.

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before significant visible damage or quantitative loss occurs.

63. (C) Clear, Few, Heavy
For operational purposes, the Food Corporation of India uses a simplified grading system to categorize grain based on the level of insect infestation. A "Clear" grade indicates no live insects are found. "Few" suggests a low-level infestation that may require prophylactic measures, while "Heavy" indicates a significant population of weevilled grains that necessitates immediate curative treatment through chemical fumigation.

64. (D) Intense heat generated by fungal respiration and metabolism in high-moisture pockets
Bin burn is a form of serious grain deterioration that occurs in bulk storage. It is caused by the metabolic activity of thermophilic fungi and high-moisture grain respiration. In localized pockets where moisture is excessive, fungal growth generates intense heat. If this heat cannot dissipate, the temperature can rise sufficiently to char or discolour the grain, making it smell burnt and reducing its quality.

65. (D) I only
Mycotoxins are toxic secondary metabolites produced by certain fungi. Aflatoxins are primarily associated with species of Aspergillus, specifically A. flavus and A. parasiticus. Ochratoxins, however, are primarily nephrotoxic, targeting the kidneys. Furthermore, while low temperatures slow down fungal growth, many species can continue to metabolize and produce toxins even at temperatures near or slightly below the freezing point.

66. (C) Affixing smooth, inverted metal cone guards (rat guards) on vertical entry routes
Rat guards are essential structural exclusion devices used in warehouse management. These are typically smooth, metal cones or disks installed around pipes, cables, and structural columns. Because rodents cannot grip the smooth, inverted surface of the guard, they are prevented from climbing upward to reach windows, ventilators, or other entry points into the grain storage areas of the building.

67. (A) Ensures structural stability and enables precise stock counting and gas sealing
Scientific block stacking is a precise method of arranging grain bags in interlocking patterns. This technique ensures that the stack remains stable and does not collapse during storage or handling. Additionally, the uniform shape and size of block stacks allow for easy and accurate counting of stock and facilitate the effective application of gas-proof covers during curative fumigation procedures.

68. (D) Anisopteromalus calandrae
Anisopteromalus calandrae is a tiny, naturally occurring hymenopteran wasp that acts as a parasitoid of several stored product beetles. It is particularly effective against the larvae of primary internal feeders like Sitophilus species. The female wasp can detect the presence of a host larva hidden inside a grain kernel and uses its ovipositor to deposit an egg directly onto the host.

69. (B) The initial population density of Sitophilus weevils
Abiotic factors are the non-living environmental components that influence the rate of grain deterioration. These include temperature, moisture content, and relative humidity, all of which regulate both grain physiology and the activity of pests. In contrast, the population density of insects like Sitophilus weevils is a biotic factor, as it involves the living organisms that directly consume and damage the grain.

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70. (A) Both A and R are true and R is the correct explanation of A.
Secondary external feeders, such as the red flour beetle, are unable to initiate an infestation in sound, intact grain. These insects lack the specialized mouthparts needed to penetrate the tough outer pericarp of a whole kernel. Consequently, they depend on pre-existing damage caused by primary feeders, mechanical handling, or milling processes to access the inner nutrients they need for development.

71. (D) Detecting semiochemicals and vibrations produced by the internally feeding host larva
The parasitoid wasp Anisopteromalus calandrae uses highly specialized sensory mechanisms to locate its host. It can detect subtle chemical signals, known as semiochemicals, as well as the minute vibrations and heat generated by a beetle

It was widely used for rapid disinfestation but has been largely phased out globally due to its role in ozone depletion. Other agents include curative fumigants like phosphine and prophylactic contact protectants like deltamethrin and malathion.

125. (A) I and III
Effective warehouse pest management requires a combination of hygiene and chemical prevention. Thoroughly cleaning the structure to remove old grain residues is a vital first step, as these materials provide breeding grounds for pests. Prophylactic measures, such as fabric spraying on the external surfaces of bags, help prevent new insects from entering the grain, though they cannot reach pests already hidden inside the kernels.

126. (C) Spraying an approved contact insecticide directly onto the exposed surfaces of the stacked gunny/jute bags
Fabric spraying is a prophylactic technique used in bag storage warehouses. It involves the application of a diluted contact insecticide, such as malathion or deltamethrin, directly onto the outer surfaces of the stacked grain bags. This creates a chemical barrier that kills any insects attempting to crawl onto or into the bags, thereby reducing the risk of cross-infestation between different grain lots.

127. (B) DDT
DDT is a notorious organochlorine insecticide that was once widely used but is now strictly prohibited for use on food grains. Its high mammalian toxicity, coupled with its extreme environmental persistence and tendency to bioaccumulate in the food chain, makes it dangerous for human health and ecosystems. Modern storage management relies on less persistent and safer alternatives like synthetic pyrethroids or biological controls.

128. (D) It exhibits high residual efficacy on surfaces and works against malathion-resistant species
Deltamethrin is a synthetic pyrethroid that has become a preferred choice in many storage programs. It offers excellent residual stability on various surfaces, meaning it remains active for a longer period compared to many organophosphates. Additionally, deltamethrin is effective against several pest populations that have already developed resistance to older chemicals like malathion, making it a more reliable tool for integrated pest management.

129. (A) A grayish-white powder primarily composed of non-toxic aluminium hydroxide
When aluminium phosphide tablets react with the moisture in the air, they release phosphine gas. Once the reaction is complete, the original tablet is reduced to a fine, grayish-white powder. This residue is primarily composed of aluminium hydroxide, which is considered non-toxic. However, it may still contain small amounts of unreacted aluminium phosphide, so it must be handled and disposed of with proper care.

130. (A) Both A and R are true and R is the correct explanation of A.
Achieving a gas-tight seal is the most important factor for a successful phosphine fumigation. Because phosphine gas is highly penetrative and can easily escape through even small gaps, sealing the edges of the covers with mud or sand-snakes is critical. This ensures that the gas concentration remains at a lethal level for a long enough period to kill all life stages of the pests.

131. (A) Pure gas is spontaneously flammable in air at concentrations exceeding 1.79% (v/v)
Phosphine gas is a powerful fumigant but requires careful handling due to its chemical properties. While it is highly effective at killing pests, it is also flammable and can spontaneously ignite in air if its concentration becomes too high. Commercial formulations are designed to release the gas slowly and often include other compounds to reduce this risk, but strict safety protocols must still be followed.

132. (D) Survival of tolerant life stages, leading to resurgence and selection for resistance
If a fumigation cover is not perfectly sealed, the phosphine gas will gradually leak out, preventing the concentration from staying high enough for long enough. This often results in the survival of the more tolerant life stages, such as eggs or pupae. These survivors can lead to a rapid resurgence of the pest population and, more dangerously, accelerate the development of genetic resistance to the fumigant.

133. (B) 0.3 ppm
Human safety is paramount when working with fumigants like phosphine. Regulatory agencies have established a Threshold Limit Value, which

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bengalensis is notorious for its aggressive hoarding of grain in deep burrows, while Rattus norvegicus is a ground-dwelling species often associated with damp areas.

81. (A) Prevent the spread of exotic storage pests across international or domestic borders
The Destructive Insects and Pests Act is the primary legal framework for plant quarantine in India. Its main objective is to prevent the introduction and spread of invasive exotic pests and diseases that could threaten agriculture. Through domestic and international quarantine measures, authorities can inspect and regulate the movement of commodities to ensure they do not carry dangerous pests into new areas.

82. (C) Accumulation of dense silken webbing over the surface of stacked gunny bags
Rodent infestations are identified by specific physical signs. These include dark, spindle-shaped fecal droppings, greasy smear marks from their fur, and gnaw marks on structures or bags. However, the presence of dense silken webbing is not associated with rodents. Webbing is a characteristic sign of infestation by certain stored product moths, whose larvae produce silk as they feed and move.

83. (A) To overcome natural neophobia and ensure rodents consume a lethal toxic dose
Pre-baiting is a critical step when using acute rodenticides like zinc phosphide. Rodents are naturally neophobic, meaning they are suspicious of new food sources. By providing non-toxic bait for several days, the rodents become accustomed to the food. When the poison is finally added, they are more likely to consume a lethal amount quickly before they can develop bait shyness.

84. (D) Accumulation of feathers, debris, and uric-acid-rich feces on grain surfaces
Avian pests cause significant qualitative loss in warehouses through contamination. Birds roosting on the rafters or trusses deposit large amounts of feathers, nesting materials, and feces directly onto the grain stacks. Their droppings are rich in uric acid and can harbor various pathogens, including Salmonella. This contamination renders the grain unhygienic and often necessitates extensive cleaning or makes it unfit for human consumption.

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85. (C) I and III
Managing avian pests requires a combination of physical and structural methods. Installing high-density polyethylene netting effectively prevents birds from entering through ventilators. Similarly, anti-roosting spikes can be placed on ledges and beams to prevent pigeons from landing and nesting. While ultrasonic devices exist, birds often habituate to them, and the use of toxic baits is generally avoided due to contamination risks.

86. (C) Columba livia (Rock pigeon)
The rock pigeon is the most common and problematic avian pest in urban and semi-urban grain storage facilities. These birds are highly adapted to human structures and prefer roosting and nesting in the high rafters and ledges of warehouses. Their presence leads to significant contamination of grain stacks with feces and feathers, posing a major challenge to hygiene and warehouse management.

87. (D) Modified Atmosphere Storage (MAS) - Involves constantly pumping ambient outside air to permanently chill the grain to freezing point
Modified Atmosphere Storage is a technique that involves changing the concentrations of oxygen, nitrogen, and carbon dioxide within a sealed storage environment to kill pests. It does not involve chilling the grain with outside air. Other physical and ecological methods include hermetic storage, which relies on natural respiration to alter gas levels, and ionizing radiation or heat treatment to kill insects.

88. (A) Lethal control inside food storage poses high risks of biological contamination
Structural exclusion is the preferred method for bird management in warehouses because it is proactive and prevents contamination. Attempting to use lethal controls, such as poisons or shooting, inside a facility where food is stored is extremely risky. Dead birds and the chemicals used to kill them can easily fall into the grain bulk, leading to serious biological and chemical hazards.

89. (B) It denatures vital proteins and destroys the viability and germination capacity
While heat treatment is an effective way to kill storage insects, it must be carefully controlled, especially for seed grain. Subjecting seeds to temperatures above 65 degrees Celsius can

dominated by resistant individuals, rendering the chemical treatment ineffective for future pest management.

142. (C) Beta-asarone
The rhizome of the sweet flag plant, Acorus calamus, has long been used as a natural protectant for stored grain. Its insecticidal and chemosterilant properties are primarily due to the presence of an active compound called beta-asarone. This biochemical principle can disrupt the reproductive systems of storage insects and cause significant mortality, making it a valuable botanical alternative for managing infestations in small-scale storage.

143. (B) As a surface predator targeting eggs and early larvae of external feeders and moths
Xylocoris flavipes, the warehouse pirate bug, is most effectively used as a biological control agent on the surface of grain stacks. Because it cannot penetrate deep into the grain bulk, its predatory activity is limited to the headspace and the outer layers of the commodity. In these areas, it can successfully hunt and consume the eggs and young larvae of various external feeders and moths.

144. (D) Neem formulations act immediately as powerful nerve poisons, knocking down flying insects in seconds
Neem-derived products do not function as fast-acting nerve poisons or knockdown agents. Instead, their efficacy comes from their roles as antifeedants and insect growth regulators. They make the grain unpalatable to pests and interfere with their hormonal systems, disrupting growth, molting, and reproduction. This results in a gradual decline in the pest population rather than an immediate kill after application.

145. (C) I, II and III
Implementing biological control in commercial warehouses faces several practical hurdles. Parasitoids often reproduce more slowly than the pests they target, making it difficult for them to control a rapidly growing infestation. Additionally, consumers generally find the presence of any live insects in food to be unacceptable. Furthermore, the routine use of contact insecticides in warehouses can kill the very parasitoids meant to provide control.

146. (C) The late-instar larva and pupa hidden inside the grain kernel
Anisopteromalus calandrae is a specialized parasitoid that targets the hidden life stages of storage beetles. The female wasp is able to detect the presence of host larvae or pupae that are developing deep within grain kernels. Using its ovipositor, the wasp pierces the seed coat and deposits its egg onto the host. The resulting wasp larva then feeds on and eventually kills the beetle before it can emerge.

147. (A) They exhibit strong neurotoxicity, often interacting with the octopaminergic system
Many essential oils derived from aromatic plants, such as eucalyptus, mint, or thyme, possess significant insecticidal properties. These oils act as volatile fumigants or contact poisons that are often neurotoxic to insects. They typically interfere with the octopaminergic system, which is a key neurotransmitter pathway in invertebrates, leading to physiological disruption, paralysis, and the eventual death of the target storage pests.

148. (D) A tube and casing with slots rotated to open compartments at precise depths
A compartmentalized grain trier is a precision tool designed for vertical sampling. It consists of two concentric tubes, both with matching slots. When the trier is inserted into the grain, the slots are closed. Once it reaches the desired depth, the inner tube is rotated to open the compartments, allowing grain from different layers to enter. This ensures that a representative sample is collected from each stratum.

149. (B) Pitfalls catch insects on the surface, while probes intercept movement in the bulk
Monitoring storage pests requires different types of traps for different locations. Pitfall traps are designed to be placed on the grain surface or the warehouse floor to capture insects that are crawling and wandering. Probe traps, however, are perforated tubes that are inserted deep into the grain bulk. These traps capture insects as they move through the interstitial spaces within the mass of the grain.

150. (C) Pheromones provide species-specific early detection long before visible grain damage
Pheromone lures are a highly effective component of an integrated pest management program. They use synthetic versions of the chemicals

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that insects use for communication to attract them to a trap. Because they are highly specific and sensitive, they can detect the presence of a particular pest species even at very low densities, providing early warning to warehouse managers well before any significant damage occurs.

151. (D) Migrating insects encounter perforations and fall into a tube they cannot climb out of
A probe trap works by taking advantage of the natural movement of insects through a grain bulk. The trap is a hollow tube with many small perforations. As insects move through the grain, they encounter the holes and fall into the trap. The interior of the trap is designed to be smooth or contains a collection vessel, making it impossible for the insects to climb back out.

152. (A) Visual inspection fails at low densities as most pests are hidden inside the bulk
Relying solely on visual inspection of the grain surface is an unreliable way to monitor for pests. Most primary internal feeders spend the majority of their life cycle hidden inside the grain kernels, where they cannot be seen. Furthermore, at low population densities, insects may be distributed throughout the bulk and not present on the surface, meaning an infestation can be well-established before it becomes visible.

153. (C) 20 bags
In grain warehouse management, the square root rule is a standard statistical guideline used to determine the appropriate sampling intensity for a large lot of bagged grain. For a stack containing exactly 400 bags, the manager would calculate the square root of 400, which is 20. This means that 20 bags must be individually sampled to obtain a representative assessment of the grain's quality and infestation level.

154. (B) Adults are wandering or cross-infesting but haven't established deep in the bulk
When pheromone traps show a high number of insects but grain samples show very few, it often indicates that adult insects are present in the warehouse but have not yet deeply infested the grain. This may happen if the insects are migrating from other areas or just recently arrived. This situation provides a critical window of opportunity for warehouse managers to initiate control measures before the pests become established.

155. (B) I, II and III
Standard grain grading protocols use specific terms to describe the level of infestation found during inspection. A "Clear" grade means no live insects were detected. "Few" indicates a low level of infestation that suggests a need for closer monitoring or prophylactic treatment. "Heavy" means a significant number of insects are present, which typically mandates immediate curative action, such as chemical fumigation, to prevent further loss.

156. (C) To inspect moving consignments to prevent the spread of isolated pests into new zones
Domestic quarantine checkpoints are established as part of a national strategy to manage agricultural pests. Their primary role is to monitor and regulate the movement of plant commodities between different regions of the country. By inspecting consignments, authorities can identify and intercept pests that are present in one area but not another, thereby preventing their spread into new, uninfested agricultural zones.

157. (D) Zero tolerance threshold - Typically applied strictly to secondary feeders in grain destined for livestock feed
Action thresholds are used to decide when to initiate pest control measures. While some situations, such as grain for export or high-value seed, may have a zero-tolerance policy, this is not usually applied to secondary feeders in livestock feed. Feed grain typically has a much higher tolerance for pests compared to grain intended for human consumption or for use as seed for future planting.

158. (C) Because structural debris provides alternative food and refuges for pest populations
Sanitation is the foundation of any successful integrated pest management program. Structural debris, such as old grain spillage and dust, provides pests with alternative food sources and protected hiding places where they can survive even if the main grain lot is treated. By removing this debris, warehouse managers eliminate these refuges, making other pest control measures, including biological control, much more effective.

159. (B) Weevilled grain
In the inspection and grading of stored grain, the term "weevilled grain" is used specifically to describe kernels that show clear evidence of

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damage from internal insect feeders. The most characteristic sign of this damage is the presence of small, circular emergence holes on the surface of the grain. These holes indicate that an insect has completed its development inside the kernel and has emerged as an adult.

160. (D) The strategic integration of prevention and monitoring with curative chemical last resorts
Integrated Pest Management is a holistic approach that differs from traditional chemical-based control. It emphasizes the use of multiple strategies, starting with prevention through sanitation and structural maintenance. Continuous monitoring is used to detect pests early, and chemical treatments are used as a curative last resort only when other methods are insufficient. This approach is more sustainable, cost-effective, and safer for both workers and consumers.

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persistently or persistently.
III. Tetranychid mites are major vectors of Luteoviruses.
IV. Pigeonpea sterility mosaic virus is transmitted by an eriophyid mite.
V. Mites utilize piercing-sucking mouthparts.
Which of the above statement(s) is/are INCORRECT?
(A) I and III
(B) II, IV and V
(C) I, III and V
(D) II and IV

2024

57. The causal agent of Pigeonpea sterility mosaic disease is transmitted by which specific vector?
(A) Aceria tulipae
(B) Aceria cajani
(C) Tetranychus urticae
(D) Brevipalpus phoenicis

2021

58. Wheat streak mosaic virus (WSMV) is a well-known pathogen transmitted by the wheat curl mite. What type of virus is WSMV?
(A) Tospovirus (family Bunyaviridae)
(B) Tritimovirus (family Potyviridae)
(C) Luteovirus (family Luteoviridae)
(D) Begomovirus (family Geminiviridae)

2025

59. Eriophyid mites are extremely small and easily dispersed. What is their primary mechanism of long-distance dissemination?
(A) Passive transport via wind currents
(B) Active continuous flight over hundreds of kilometers
(C) Attachment to migratory bird feathers
(D) Transstadial movement through soil profiles

2017

60. Unlike insect vectors, eriophyid mites exhibit an extraordinarily high degree of host specificity. What is a consequence of this specificity for viral epidemiology?
(A) The viruses they transmit tend to have very broad host ranges.
(B) The mites rapidly adapt to non-host plants when starved.
(C) The viruses they transmit are usually restricted to one or a few related plant species.
(D) Vector control requires broad-spectrum systemic insecticides targeting all local flora.

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2023

61. Brevipalpus mites (false spider mites) are historically significant for transmitting viruses that cause diseases in which economically important perennial crop?
(A) Sugarcane and related graminaceous crops.
(B) Wheat and small grain cereal varieties.
(C) Cotton and other Malvaceous fiber crops.
(D) Citrus (e.g., Citrus leprosis virus).

2006

62. Mycangia are specialized structures found in certain insect vectors primarily utilized for what function?
(A) Synthesizing viral coat proteins internally.
(B) Filtering fastidious bacteria from xylem sap.
(C) Storing and transporting fungal spores.
(D) Housing defensive toxic secretions for protection.

2011

63. Consider the following steps involved in the transmission of Dutch elm disease:
I. Adult beetles emerge from infected dead wood carrying spores.
II. Larvae pupate in the galleries of the dead tree.
III. Beetles feed on the twig crotches of healthy elm trees.
IV. The fungus spreads systemically through the tree's xylem, causing wilt.
Which of the following represents the correct chronological sequence?
(A) I - III - IV - II
(B) I - IV - III - II
(C) II - I - III - IV
(D) III - I - II - IV

2013

64. Mango malformation disease is strongly associated with which type of interaction?
(A) Whiteflies transmitting a Begomovirus.
(B) Aphids injecting phytoplasmas during probing.
(C) Bark beetles transmitting a systemic xylem fungus.
(D) Eriophyid mites assisting fungal entry.

2002

65. The primary role of the vector in many fungus-vector associations, such as those involving bark beetles, is:
(A) To deposit spores directly into susceptible woody tissues.
(B) To provide an internal environment for fungal sexual reproduction.

(B) Potyviruses
(C) Cucumoviruses
(D) Alfamoviruses

2012

9. Rasping-sucking mouthparts are morphologically characteristic of which insect vector group?
(A) Aphids
(B) Thrips
(C) Leafhoppers
(D) Whiteflies

2024

10. Which physical barrier must persistent-circulative viruses bypass immediately after being ingested into the vector's alimentary canal?
(A) The foregut cuticle lining
(B) The midgut epithelial cells
(C) The Malpighian tubules
(D) The principal salivary gland

2009

11. Chewing mouthparts are typically associated with vectors that transmit pathogens through which mechanism?
(A) Gross mechanical transmission during feeding via regurgitation.
(B) Biological propagative transmission throughout the vector's life.
(C) Circulative non-propagative transmission via internal transport.
(D) Stylet-borne transient transmission during superficial probes.

2019

12. Salivary sheath formation is a critical behavioral feeding adaptation observed in which of the following vector groups?
(A) Thrips
(B) Beetles
(C) Aphids
(D) Grasshoppers

2025

13. Which viral transmission mechanism utilizes a helper component protein encoded by the virus to facilitate temporary binding to the aphid's stylet?
(A) Circulative
(B) Propagative
(C) Transovarial
(D) Non-persistent

2013

14. Match the aphid-transmitted virus genus with its respective transmission mechanism:
List I: (Virus Genus)
P. Potyvirus
Q. Luteovirus
R. Caulimovirus
S. Enamovirus
List II: (Transmission Mechanism)
1. Persistent-circulative
2. Non-persistent
3. Semi-persistent
4. Persistent-circulative (helper-dependent)
(A) P-2, Q-1, R-3, S-4
(B) P-1, Q-2, R-4, S-3
(C) P-3, Q-4, R-2, S-1
(D) P-2, Q-3, R-1, S-4

2015

15. The phenomenon of "probing" in aphids primarily facilitates the acquisition of which type of plant viruses?
(A) Xylem-limited viruses within the vascular tissue.
(B) Non-persistent viruses in the epidermal tissue.
(C) Phloem-limited luteoviruses during sustained feeding.
(D) Persistent-propagative viruses after internal replication.

2004

16. During host finding, aphids predominantly rely on which visual cue to locate susceptible plants before landing?
(A) Red light reflectance
(B) Ultraviolet light absorption
(C) Infrared thermal emission
(D) Yellow-green light reflectance

2013

17. Which of the following aphid species is globally recognized as the most polyphagous and efficient vector for numerous plant viruses?
(A) Myzus persicae
(B) Acyrthosiphon pisum
(C) Toxoptera citricida
(D) Rhopalosiphum padi

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2002

18. Why do non-persistent viruses lack a latent period in their aphid vectors?
(A) They rapidly replicate in the foregut almost immediately upon ingestion.
(B) They bypass the midgut barrier through a process of passive diffusion.
(C) They are retained on the inner surface of the maxillary stylets.

(D) They utilize specific vector enzymes to initiate a host infection.

2017

19. Identify the INCORRECT statement regarding aphid transmission dynamics.
(A) Luteoviruses undergo massive replication within the aphid midgut prior to transmission.
(B) Pre-acquisition starvation often increases the efficiency of non-persistent virus transmission.
(C) Alate (winged) morphs play a superior role in the epidemiological spread of viruses over long distances.
(D) Aphid saliva contains enzymes that can elicit defense responses or facilitate viral entry.

2021

20. The synergistic interaction required for Rice tungro disease transmission depends on leafhoppers acquiring which components?
(A) Only Rice tungro bacilliform virus (RTBV) without any additional components.
(B) Only Rice tungro spherical virus (RTSV) independently of other viral particles.
(C) RTBV first, followed by RTSV which then acts as a functional transstadial coat.
(D) RTSV acting as a necessary helper for the acquisition of RTBV.

2015

21. Consider the following statements regarding the transmission of mollicutes by leafhoppers:
I. Phytoplasmas are exclusively non-persistent.
II. Phytoplasmas multiply within the vector's tissues.
III. Spiroplasmas undergo a latent period before transmission.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2010

22. Which fastidious pathogen is primarily transmitted by the leafhopper genus Nephotettix?
(A) Citrus greening bacterium
(B) Xylella fastidiosa
(C) Rice yellow dwarf phytoplasma
(D) Tomato spotted wilt virus

2006

23. Planthoppers (Delphacidae) are notably distinct from leafhoppers (Cicadellidae) in their transmission of which specific class of plant viruses?
(A) Begomoviruses
(B) Closteroviruses
(C) Cucumoviruses
(D) Tenuiviruses

2006

24. A defining characteristic of xylem-feeding leafhoppers (sharpshooters) is their role in disseminating which type of plant pathogen?
(A) Xylem-limited bacteria such as Xylella fastidiosa.
(B) Phloem-limited fastidious bacteria in the sieve tubes.
(C) Epidermal non-persistent viruses during brief probes.
(D) Fungal spores that cause widespread vascular wilts.

2006

25. What is the primary reason phytoplasmas require a prolonged latent period in their leafhopper vectors?
(A) The pathogen needs time to degrade the chitinous lining within the vector's foregut.
(B) The pathogen traverses the hemocoel and replicates before reaching the glands.
(C) The vector must undergo a molting process to activate the phytoplasma's infectivity.
(D) The phytoplasma must conjugate with gut microbiota to synthesize key helper proteins.

2005

26. Which of the following represents an INCORRECT pairing between a hopper vector and its corresponding disease?
(A) Nilaparvata lugens - Rice grassy stunt virus
(B) Sogatella furcifera - Wheat streak mosaic
(C) Dalbulus maidis - Corn stunt spiroplasma
(D) Nephotettix virescens - Rice tungro disease

2001

27. The cryptic species complex of Bemisia tabaci is functionally divided into biotypes. Which biotype is considered globally the most invasive and agriculturally devastating?
(A) Biotype A (original)
(B) Biotype B (MEAM1)
(C) Biotype Q (MED-type)
(D) Biotype K (emergent)

2014

28. Choose the correct sequence of events for a Begomovirus circulating through a whitefly vector.

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(A) Midgut → Hemolymph → Primary salivary gland
(B) Hemolymph → Midgut → Primary salivary gland
(C) Primary salivary gland → Hemolymph → Midgut
(D) Midgut → Primary salivary gland → Hemolymph

2008

29. Begomoviruses cause severe diseases such as Cotton leaf curl. These viruses are transmitted by Bemisia tabaci in which manner?
(A) Persistent-propagative
(B) Semi-persistent
(C) Non-persistent
(D) Persistent-circulative

2001

30. Which cellular chaperone protein in the whitefly hemolymph is critical for protecting Begomoviruses from degradation during circulation?
(A) Heat shock protein 70 (HSP70) found in the cytoplasm.
(B) Chitinase-like proteins present in the vector hemolymph.
(C) GroEL homologue produced by secondary endosymbionts.
(D) Vector-encoded helper component proteases for protection.

2001

31. Whiteflies transmit criniviruses (e.g., Tomato chlorosis virus) via which specific mechanism?
(A) Persistent-propagative
(B) Semi-persistent
(C) Persistent-circulative
(D) Non-persistent

2012

32. In the context of whitefly transmission, transovarial passage of Begomoviruses to the next generation is generally considered to be:
(A) The primary mode of epidemic initiation
(B) Highly efficient and universally occurring in all biotypes
(C) Dependent on co-infection with phytoplasmas
(D) Extremely rare or absent

2025

33. Unlike aphids, whiteflies typically locate their host plants using which combination of sensory modalities?
(A) Visual attraction to yellow-green and gustatory probing.
(B) Olfactory cues derived from volatile organic plant compounds.
(C) Acoustic vibrations emitted by the internal plant vascular stems.
(D) Pheromone trails left by previous populations on the leaf surface.

2006

34. What is the most unique aspect of Tospovirus acquisition by thrips vectors?
(A) It can only be acquired by adult thrips through deep xylem feeding.
(B) It requires simultaneous acquisition of a fungal helper pathogen.
(C) It is exclusively acquired during the first and second larval instars.
(D) It occurs purely mechanically through external body contamination.

2001

35. Consider the following statements concerning thrips and Tospoviruses:
I. Tospoviruses multiply in the thrips' salivary glands.
II. Thrips transmit Tospoviruses non-persistently.
III. Frankliniella occidentalis is a major vector of Tomato spotted wilt virus.
IV. Adults that acquire the virus for the first time can transmit it immediately.
Which of the above statement(s) is/are INCORRECT?
(A) I and III
(B) II and IV
(C) I, II and IV
(D) I and IV

2022

36. Thrips feeding mechanics are characterized as "punch and suck". Which cellular structure is typically emptied of its contents during brief feeds, facilitating virus entry?
(A) Phloem sieve elements
(B) Xylem vessel tubes
(C) Guard cell structures
(D) Epidermal and mesophyll cells

2021

37. Transstadial transmission in vector biology, as observed in thrips, refers strictly to:
(A) The passage of the pathogen from the adult vector to its eggs.
(B) The retention of the pathogen through successive developmental molts.
(C) The mechanical transfer of pathogens

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CHAPTER 14
Arthropod Vectors of Plant Diseases

2005

1. What defines the latent period in the context of vector-borne plant disease transmission?
(A) The time from pathogen acquisition until the vector is capable of transmission.
(B) The duration required for a vector to feed on an infected plant to successfully acquire the pathogen.
(C) The total time a vector remains infective after moving away from the source plant or initial host.
(D) The duration during which the host plant shows visible symptoms after being successfully inoculated.

2022

2. Which term best describes the duration for which a vector can efficiently transmit a pathogen without re-acquiring it from an infected source?
(A) Inoculation access period
(B) Transmission threshold
(C) Retention time
(D) Incubation period

2008

3. In transmission efficiency studies, the inoculation access period refers to the time a viruliferous vector must spend doing what?
(A) Feeding on a healthy host plant to ensure successful pathogen transmission.
(B) Surviving the internal replication and circulation of the acquired pathogen.
(C) Interacting with alternate hosts to bypass innate physiological resistance mechanisms.
(D) Completing its physiological molting process before initiating further feeding.

2012

4. How does transmission efficiency typically correlate with the duration of the acquisition access period in persistent viruses?
(A) Efficiency remains constant regardless of the feeding duration on the infected host.
(B) Efficiency increases with longer feeding times up to a specific saturation point.
(C) Efficiency decreases proportionally as feeding time extends beyond one minute of activity.
(D) Efficiency is determined solely by the length of the vector's lifespan.

2012

5. Which sequence correctly orders the fundamental phases of biological transmission by an insect vector?
(A) Latent period, Inoculation access period, Acquisition access period
(B) Acquisition access period, Latent period, Inoculation access period
(C) Inoculation access period, Acquisition access period, Latent period
(D) Latent period, Acquisition access period, Inoculation access period

2008

6. A vector's ability to maintain and transmit a pathogen throughout its entire lifespan without re-acquisition characterizes which type of transmission?
(A) Non-persistent
(B) Semi-persistent
(C) Persistent
(D) Transient mechanical

2002

7. Consider the following statements regarding the transmission of phloem-limited viruses:
Assertion (A): Piercing-sucking mouthparts are essential for the transmission of phloem-limited viruses.
Reason (R): These mouthparts allow vectors to penetrate deep tissue layers and directly deposit viruses into the vascular system.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2009

8. The accessory salivary gland in aphids acts as a primary internal barrier during the transmission of which class of plant viruses?
(A) Luteoviruses

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acquire circulative viruses.
(D) Phloem sap is inherently toxic to most known coleopteran species.

2024

48. Gross mechanical transmission by beetles typically involves a specific retention period. This retention is fundamentally due to:
(A) Viral replication within the vector's internal foregut epithelium.
(B) Slow release of virus particles bound to the mouthpart sensilla.
(C) Continual re-acquisition from contaminated regurgitant in the crop.
(D) Stable survival of the virus in the hemolymph for several days.

2005

49. Match the insect vector with the pathogen type it is most characteristically known to transmit mechanically:
List I: (Insect Vector)
P. Flea beetle
Q. Honey bee
R. Aphid
S. Bark beetle
List II: (Pathogen Type)
1. Fungal spores
2. Tymoviruses
3. Floral infecting bacteria
4. Non-persistent epidermal viruses
(A) P-2, Q-3, R-4, S-1
(B) P-3, Q-1, R-2, S-4
(C) P-4, Q-2, R-1, S-3
(D) P-1, Q-4, R-3, S-2

2009

50. Dissemination of bacterial wilt (e.g., Ralstonia solanacearum) by insects can occur incidentally through which mechanism?
(A) Deposition of contaminated frass on foliar surfaces.
(B) Propagative transmission via the insect's salivary glands.
(C) Mechanical transfer of ooze on mouthparts.
(D) Internal symbiosis within the insect's midgut bacteriocytes.

2002

51. Flies and bees primarily serve as incidental vectors for diseases that affect which part of the host plant?
(A) Blossoms and floral tissues
(B) Subterranean tubers
(C) Vascular root systems
(D) Xylem vessels of the main stem

2015

52. Erwinia amylovora, the causal agent of fire blight, is famously disseminated by bees. How does this transmission typically occur?
(A) Bees inject the bacteria while extracting nectar from the flowers.
(B) The bacteria multiply in the bee's gut and are excreted onto leaves.
(C) Bees carry infected pollen internally and transovarially to offspring.
(D) Bacteria from ooze adhere to the bee's body and are transferred.

2008

53. The fungal pathogen Monilinia fructicola, which causes brown rot in stone fruits, is frequently spread by which type of vectors?
(A) Phloem-feeding aphids visiting healthy leaf tissues.
(B) Frugivorous flies and sap beetles visiting wounded fruit.
(C) Soil-dwelling nematodes interacting with the roots.
(D) Spider mites feeding on the underside of foliage.

2016

54. What is a key characteristic of the incidental mechanical transmission mediated by flies and bees?
(A) High vector specificity based on specific receptor-ligand interactions.
(B) A strict requirement for a latent period before transmission occurs.
(C) Environmental contamination and physical contact.
(D) Dependence on viral helper proteins found in the insect saliva.

2019

55. While feeding on floral nectar, insects can transmit diseases by mechanically bypassing the plant's primary defense barriers. Which plant surface allows easiest pathogen entry in flowers?
(A) The heavily cutinized petals
(B) The sepal trichomes
(C) The waxy pedicel
(D) The nectaries and stigmatic surfaces

2025

56. Consider the following statements concerning mite vectors:
I. Mites belong to the class Insecta.
II. Eriophyid mites transmit viruses semi-

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between mating vectors.
(D) The movement of pathogens from vector saliva into host phloem.

2014

38. Which anatomical feature of larval thrips allows Tospoviruses to efficiently reach the salivary glands?
(A) The total absence of an epithelial lining in the larval foregut.
(B) The presence of specialized viral transport channels in the exoskeleton.
(C) A temporary connection between the midgut and salivary glands.
(D) The lack of an immune system in the hemocoel prior to the pupation stage.

2021

39. Candidatus Liberibacter asiaticus, the causative agent of Citrus greening (HLB), is primarily vectored by:
(A) Trioza erytreae
(B) Bemisia tabaci
(C) Scirtothrips dorsalis
(D) Diaphorina citri

2012

40. How does the psyllid vector acquire the Citrus greening pathogen?
(A) Through prolonged phloem ingestion from infected citrus plants.
(B) By grazing on the epidermal cells of infected citrus leaves.
(C) Mechanically via the contamination of its ovipositor.
(D) Exclusively through transovarial transmission from infected mothers.

2019

41. Psyllids transmit phloem-restricted fastidious bacteria in a manner that is fundamentally classified as:
(A) Semi-persistent
(B) Persistent-propagative
(C) Non-persistent
(D) Transient mechanical

2004

42. Consider the following statements regarding the management of Citrus greening disease:
Assertion (A): Control of Citrus greening disease primarily relies on managing psyllid populations.
Reason (R): Candidatus Liberibacter species cannot currently be cultured in vitro, making chemical cures for infected trees practically unviable.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2001

43. Which psyllid-transmitted disease affects solanaceous crops and is caused by Candidatus Liberibacter solanacearum?
(A) Potato zebra chip
(B) Tomato spotted wilt
(C) Pepper mild mottle
(D) Tobacco mosaic

2014

44. What morphological feature distinguishes psyllids from aphids, contributing to their distinct feeding behaviors and transmission profiles?
(A) Complete lack of feeding stylets.
(B) Absence of functional salivary glands.
(C) Jumping hind legs and rigid wings.
(D) Exclusively chewing type mouthparts.

2018

45. Beetles and weevils primarily transmit plant viruses belonging to which specific genera?
(A) Potyvirus, Luteovirus, and Begomovirus
(B) Tospovirus, Cucumovirus, and Bromovirus
(C) Closterovirus, Caulimovirus, and Enamovirus
(D) Comovirus, Tymovirus, and Sobemovirus

2014

46. The mechanism of viral transmission by leaf-feeding beetles relies significantly on which physiological action?
(A) Secretion of virus-laden saliva directly into the host phloem.
(B) Persistent circulation of the virus through the beetle hemocoel.
(C) Regurgitation of digestive fluids containing viable virus particles.
(D) Penetration of the leaf stomata by the beetle's ovipositor tip.

2005

47. Why are chewing insects like beetles ineffective vectors for phloem-limited viruses like Luteoviruses?
(A) Their midgut environments rapidly denature all viral coat proteins.
(B) Massive tissue destruction prevents precise delivery to the phloem.
(C) They lack the necessary gut receptors to

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(C) To actively inject fungal spores into the plant's phloem tissue.
(D) To degrade the fungal toxins before they kill the host plant.

2016

66. How does the Laurel wilt pathogen (Raffaelea lauricola) establish infection in a new host via its vector, the redbay ambrosia beetle?
(A) The beetle excretes the fungus onto the leaf surface for entry.
(B) The beetle relies on the fungus to break down the host defenses.
(C) The beetle introduces the fungus into its galleries.
(D) The fungus is carried externally and drops into floral nectaries.

2008

67. The relationship between Ophiostoma novo-ulmi and elm bark beetles is best characterized as:
(A) Mutualistic symbiosis for food and transport.
(B) Antagonistic interaction leading to vector death.
(C) Exclusive persistent-circulative viral transmission.
(D) Non-persistent mechanical carriage of fungal spores.

2015

68. The formation of biofilms in the foregut of sharpshooter leafhoppers is the primary retention mechanism for which bacterial pathogen?
(A) Candidatus Liberibacter asiaticus
(B) Erwinia amylovora
(C) Ralstonia solanacearum
(D) Xylella fastidiosa

2021

69. Why is the transmission of Xylella fastidiosa considered non-persistent or semi-persistent despite being a bacterium?
(A) Because it circulates in the hemolymph but does not replicate.
(B) Because it binds to the foregut cuticle and is lost when the vector molts.
(C) Because it rapidly degrades in the midgut within hours.
(D) Because it requires a helper virus to attach to the stylets.

2017

70. Consider the following statements regarding the mechanisms of biofilm-mediated bacterial transmission in vectors:
I. The biofilm protects bacteria from the vector's digestive enzymes.
II. Disruption of the biofilm during feeding releases planktonic cells into the plant.
III. Biofilms are typically formed in the vector's hindgut.
Which of the above statement(s) is/are correct?
(A) I and III
(B) I and II
(C) II and III
(D) I, II and III

2018

71. Bacterial pathogens transmitted by xylem-feeding insects typically cause diseases characterized by which primary symptom?
(A) Mosaic and mottling
(B) Leaf enations and galls
(C) Powdery mildew and necrosis
(D) Scorch, wilting, and stunting

2016

72. Which physiological trait of sharpshooters makes them exceptionally efficient vectors for xylem-limited bacteria?
(A) They process large volumes of xylem sap.
(B) They feed exclusively on immature phloem.
(C) They possess highly acidic salivary secretions.
(D) They undergo transovarial transmission of bacteria.

2024

73. In terms of vector interactions, how does the systemic spread of phytoplasmas differ from surface-contaminating bacteria?
(A) Phytoplasmas never enter the vector's hemolymph.
(B) Phytoplasmas must replicate within the vector's organs.
(C) Surface bacteria undergo a mandatory latent period in the gut.
(D) Phytoplasmas are lost upon molting but surface bacteria remain.

2006

74. Phytoplasmas are specialized wall-less bacteria. Within the insect vector, their multiplication primarily induces which measurable effect?
(A) Significant enhancement of vector longevity and fecundity.
(B) Cytopathological effects reducing vector output.
(C) Immediate death of the vector upon hemolymph entry.
(D) Morphological transformation of the vector into an alate.

NODIA

aphid vector.

2004

146. A classic characteristic of helper-dependent non-persistent transmission (e.g., Potyviruses) is the presence of which motif on the viral coat protein that interacts with the helper component?
(A) RGD (Arg-Gly-Asp)
(B) KDEL
(C) DAG (Asp-Ala-Gly)
(D) NLS (Nuclear Localization Signal)

2024

147. Consider the following statements regarding mealybug transmission of viruses:
Assertion (A): Mealybugs are efficient vectors of certain closteroviruses, such as Grapevine leafroll-associated viruses.
Reason (R): Mealybugs possess highly mobile, winged adult females that can rapidly spread viruses across large vineyards.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2014

148. Which factor most heavily dictates the spatial distribution pattern of soil-borne viral diseases transmitted by nematodes?
(A) Wind direction during the primary planting season of the crop.
(B) The flight range of the alternate insect vector in the area.
(C) The availability of volatile attractants released by the roots.
(D) Patchy, aggregated distribution of nematode populations.

2013

149. Though not explicitly listed among major insect classes, nematodes are vital vectors. Which genus of nematode is classically associated with the transmission of Nepoviruses (e.g., Tomato ringspot virus)?
(A) Meloidogyne
(B) Xiphinema
(C) Heterodera
(D) Pratylenchus

2005

150. Olpidium brassicae, a soil-borne zoosporic fungus, acts as a vector for which of the following?
(A) Tobacco mosaic virus
(B) Cucumber mosaic virus
(C) Lettuce big-vein virus
(D) Potato leafroll virus

2022

151. Which best describes the concept of a "viruliferous" vector?
(A) A vector that is genetically susceptible to a specific virus.
(B) A vector that has lost its ability to transmit due to molting.
(C) A vector that solely acts as a dead-end host for a virus.
(D) A vector that carries the pathogen and can transmit it.

2008

152. In an agricultural setting, why might an application of a contact insecticide inadvertently increase the spread of a non-persistent virus?
(A) Sub-lethal doses agitate vectors, causing numerous short probes.
(B) The chemical reacts with the virus to increase its internal titer.
(C) The insecticide sterilizes the soil, removing antagonistic microbes.
(D) It kills the primary host plant, forcing vectors onto local weeds.

2005

153. What is the fundamental mechanism by which oil sprays reduce the transmission of non-persistent viruses?
(A) Oils cause rapid toxicity and mortality to the aphid vectors.
(B) Oils interfere with virion retention on stylets or probing.
(C) Oils induce systemic acquired resistance (SAR) within the plant.
(D) Oils block the stomata, preventing viral entry into the mesophyll.

2015

154. Match the viral classification with its corresponding type of vector transmission:
List I: (Viral Classification)
P. Tospovirus
Q. Begomovirus
R. Potyvirus
S. Cucumovirus
List II: (Type of Vector Transmission)
1. Aphid (Non-persistent)
2. Thrips (Persistent-propagative)
3. Whitefly (Persistent-circulative)
4. Aphid (Non-persistent, non-helper

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1. Persistent-propagative
2. Non-persistent
3. Semi-persistent
4. Persistent-circulative

(A) P-3, Q-4, R-1, S-2
(B) P-2, Q-4, R-3, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-4, Q-3, R-2, S-1

2024

85. During persistent-circulative transmission, Luteoviruses traverse the vector's barriers via a process known as:
(A) Passive diffusion through paracellular spaces
(B) Receptor-mediated endocytosis and exocytosis
(C) Active replication-driven lysis of gut cells
(D) Mechanical puncture by stylet movements

2012

86. Which physiological property ensures that persistent-circulative viruses are not rapidly degraded by the vector's immune system in the hemolymph?
(A) Encapsidation with vector-derived lipids
(B) Immediate integration into the vector's DNA
(C) Binding to symbiotic chaperonins like GroEL
(D) Synthesis of viral proteases that destroy hemocytes

2017

87. The accessory salivary gland (ASG) basal lamina serves as a critical selection barrier, determining vector specificity for which group of viruses?
(A) Cucumoviruses
(B) Potyviruses
(C) Bromoviruses
(D) Luteoviruses

2018

88. Persistent-circulative transmission is characterized by the absolute absence of which process?
(A) Viral replication within the vector
(B) Viral movement through the hemolymph
(C) A latent period before transmission
(D) Endocytotic traversal of the hindgut

2016

89. Cytopathological structures, such as viral inclusion bodies or massive virion aggregations in vector tissues, are definitive indicators of:
(A) Stylet-borne transmission
(B) Persistent-propagative transmission
(C) Semi-persistent transmission
(D) Transstadial passive carriage

2008

90. Which of the following virus families is classically known for persistent-propagative transmission in both plant and insect hosts?
(A) Potyviridae
(B) Rhabdoviridae
(C) Luteoviridae
(D) Closteroviridae

2018

91. Consider the following statements regarding persistent-propagative transmission:
I. Virions replicate in the midgut, hemocytes, and salivary glands.
II. Transovarial transmission is frequently observed.
III. The latent period is strictly dependent on the time required for virions to diffuse passively to the salivary glands.
IV. Vectors may suffer deleterious effects from the viral infection.

Which of the above statement(s) is/are INCORRECT?
(A) I and II
(B) II and III
(C) III
(D) IV

2018

92. Why does transovarial transmission present a major challenge for the management of persistent-propagative viruses?
(A) The virus mutates rapidly during egg fertilization.
(B) The vector population is rendered sterile, causing unpredictable population crashes.
(C) Vector offspring hatch already viruliferous without needing to feed on infected plants.
(D) Eggs become physically resistant to all known chemical insecticides.

2024

93. Vertical transmission in vector epidemiology refers exclusively to:
(A) Movement of the pathogen from the roots to the shoots of the plant.
(B) Transfer of the pathogen from a vector to an alternate host weed.
(C) The mechanical dropping of contaminated frass onto lower leaves.
(D) Spread of the pathogen from an infected parent vector to its progeny.

2018

94. Phytotoxemia in plants is directly induced by:
(A) Massive replication of viruses in plant

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2006

75. Transovarial transmission of phytoplasmas allows the pathogen to bypass which epidemiological bottleneck?
(A) The need for an initial acquisition feeding by offspring.
(B) The midgut barrier of the adult female vector.
(C) The necessity of a latent period in the host plant.
(D) The plant's innate chemical defenses against the saliva.

2002

76. Which barrier in the insect vector is crucial for spiroplasmas to traverse in order to achieve systemic infection of the vector?
(A) Cuticular lining of the foregut
(B) Exocuticle of the thorax
(C) Midgut epithelial cells
(D) Myelin sheaths of the central nervous system

2023

77. Consider the following statements regarding leafhopper transmission of phytoplasmas:
Assertion (A): Leafhoppers are the exclusive vectors for all known plant pathogenic phytoplasmas.
Reason (R): Only leafhoppers possess the specific midgut receptors required for phytoplasma attachment and endocytosis.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2023

78. Active mechanical pathogen transmission typically implies that the pathogen is:
(A) Retained internally and replicated before delivery.
(B) Carried as transient surface contamination.
(C) Integrated into the host plant's genome upon inoculation.
(D) Sheltered in specialized mycangia for fungal transport.

2013

79. Stylet-borne viruses transmitted non-persistently are most efficiently acquired during which phase of aphid behavior?
(A) Prolonged phloem sap ingestion from the plant.
(B) Brief, superficial probes in the epidermis.
(C) Sustained xylem sap extraction from the vessel.
(D) Regurgitation of foregut contents into the wound.

2025

80. For non-persistent transmission, the term "helper component" describes:
(A) A vector-encoded enzyme that breaks down viral capsids.
(B) A plant-encoded protein that facilitates viral entry into cells.
(C) A secondary virus that must be co-transmitted for infection.
(D) A protein bridging the virion to the insect stylet.

2019

81. Loss of infectivity post-molting is a hallmark of which two types of transmission?
(A) Non-persistent and semi-persistent
(B) Persistent-circulative and persistent-propagative
(C) Transovarial and transstadial
(D) Mechanical and propagative

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2024

82. Which statement correctly differentiates semi-persistent from non-persistent transmission?
(A) Semi-persistent viruses replicate in the vector, unlike non-persistent.
(B) Non-persistent viruses circulate in the hemolymph of the vector insect.
(C) Semi-persistent viruses require longer acquisition time.
(D) Semi-persistent transmission requires a helper component for survival.

2017

83. The primary anatomical retention site for semi-persistent viruses in aphid vectors is:
(A) The inner lining of the foregut.
(B) The tip of the maxillary stylets.
(C) The microvilli of the midgut.
(D) The accessory salivary glands.

2014

84. Match the viral retention characteristic with its correct transmission category:
List I: (Viral Retention Characteristic)
P. Lost immediately upon molting
Q. Retained after molting but no replication
R. Multiplies within vector tissues
S. Retained on stylet tips for very short durations
List II: (Transmission Category)

host reservoirs.
(D) Novel biotypes capable of breaking host resistance.

2025

104. Which meteorological event heavily influences the long-distance migration patterns of leafhoppers, such as the spread of Rice tungro vectors?
(A) Prevailing monsoon wind currents
(B) Localized hail storms
(C) Winter inversions
(D) Extreme drought events

2011

105. Consider the following statements regarding the role of weed reservoirs in vector-borne disease epidemiology:
I. They serve as an overwintering host for vectors.
II. They act as an oversummering source of viral inoculum.
III. They always exhibit severe symptoms, making them easy to identify and eradicate.
IV. They facilitate the bridging of disease between primary crop seasons.
V. They frequently harbor secondary endosymbionts needed by the virus.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) II, III and V
(C) I, III, IV and V
(D) I, II, III and IV

2023

106. In the epidemiology of Papaya ringspot virus (PRSV), cucurbitaceous weeds primarily serve what function during the off-season?
(A) A dead-end host that destroys the virus during transmission.
(B) An alternate host that maintains the viral inoculum.
(C) A toxic trap crop that reduces the resident aphid populations.
(D) A physical barrier preventing aphid landing on the primary crop.

2016

107. Oversummering of the leafhopper vector Orosius albicinctus on weed hosts is a critical epidemiological factor for which major Indian agricultural disease?
(A) Sesame phyllody
(B) Banana bunchy top
(C) Cotton leaf curl
(D) Citrus tristeza

2007

108. The most effective strategy to break the epidemiological cycle sustained by weed reservoirs is:
(A) Spraying the weeds exclusively with fungicides and bactericides.
(B) Cultivating the weeds alongside the main crop as a buffer zone.
(C) Implementing a crop-free period and regional weed eradication.
(D) Releasing massive numbers of vectors onto weeds to deplete inoculum.

2005

109. Which factor most critically governs the spatial spread of Banana bunchy top virus (BBTV) in a plantation?
(A) Wind-blown seeds from infected banana plants in the field.
(B) Aggressive, long-distance flight of viruliferous thrips adults.
(C) Surface water runoff moving contaminated soil into the plantation.
(D) Short-distance dispersal of aphids from infected mats.

2013

110. Temporal dynamics of Cotton leaf curl disease epidemics in North India are heavily driven by the population explosion of Bemisia tabaci during which period?
(A) The peak winter months of December and January in the north.
(B) The dry, scorching pre-monsoon summer across the region.
(C) High humidity and moderate temperatures post-monsoon.
(D) Immediately after the harvest of the cotton crop in the area.

2014

111. The rapid spread of Papaya ringspot virus (PRSV) is often very difficult to control with standard contact insecticides because:
(A) The virus replicates inside the insecticide droplets on leaves.
(B) Transmission during brief probes before insecticides can kill.
(C) PRSV is transmitted persistently, requiring long feeding durations.
(D) The aphids hide strictly underground where sprays cannot reach them.

2013

112. Consider the following statements regarding cultural management of vector-borne diseases:

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(B) An increase in alate morph frequency due to a lack of crowding.
(C) Enhanced transmission efficiency of all viral classes in the host.
(D) Reduced vector size and lowered reproductive rates.

2006

129. Transgenic resistance against a specific viral vector often employs genes derived from:
(A) Naturally occurring insecticidal proteins like Bt toxins.
(B) The vector's primary endosymbiont found in the gut.
(C) The viral coat protein, preventing vector landing on leaves.
(D) Plant growth promoting rhizobacteria in the soil system.

2004

130. RNA interference (RNAi) as a modern approach to vector control targets which biological component?
(A) The synthesis of structural carbohydrates in the plant cell wall.
(B) The viral DNA genome directly as it enters the plant nucleus.
(C) mRNA transcripts of essential genes causing gene silencing.
(D) The plant's internal hormone balance to induce premature senescence.

2024

131. A critical requirement for the success of plant-mediated RNAi against an insect vector is that the vector must:
(A) Ingesting quantities of dsRNA or siRNA from the plant.
(B) Be exclusively a chewing insect within the crop ecosystem.
(C) Have a genome completely devoid of native RNAi machinery.
(D) Be incapable of transovarial transmission of any pathogens.

2023

132. Targeting the vATPase gene in whiteflies through RNAi primarily disrupts which physiological process?
(A) Chitin synthesis during the molting process.
(B) Formation of primary visual pigments in the eyes.
(C) Production of male gametes for reproduction.
(D) Energy metabolism and ion transport in gut cells.

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2015

133. Consider the following steps involved in deploying plant-mediated RNAi for vector control:
I. Ingestion of dsRNA by the feeding insect vector.
II. Cleavage of dsRNA into siRNAs by the insect's Dicer enzyme.
III. Engineering the host plant to express vector-specific double-stranded RNA (dsRNA).
IV. Degradation of the target mRNA by the RISC complex, causing insect mortality.
Which of the following represents the correct sequence of events?
(A) III - I - II - IV
(B) I - III - II - IV
(C) III - II - I - IV
(D) II - IV - III - I

2016

134. Which of the following statements best illustrates a significant challenge in utilizing RNAi against phloem-feeding vectors?
(A) Phloem sap completely digests all dsRNA molecules in the plant.
(B) Phloem-feeders bypass RNAi machinery by lacking a midgut system.
(C) Maintaining stable concentrations of dsRNA in phloem sap.
(D) RNAi causes the host plant to become susceptible to bacterial wilts.

2019

135. What defines "non-preference" in classical host plant resistance terminology?
(A) Antibiosis
(B) Tolerance
(C) Escape
(D) Antixenosis

2006

136. Why is tolerance often considered less desirable than antibiosis or antixenosis for managing vector-borne viruses?
(A) Tolerant plants serve as hidden reservoirs for susceptible crops.
(B) Tolerant plants are rapidly killed by the acquired viruses.
(C) Tolerance causes the virus to mutate into highly aggressive forms.
(D) Tolerant plants require substantially higher pesticide inputs to survive.

2001

137. Which behavioral response does a vector exhibit when encountering a plant with strong antixenotic resistance?

2021

120. Which chemical control strategy is most logical for managing a persistently transmitted virus like Cotton leaf curl virus?
(A) Systemic insecticides as seed treatments to kill vectors.
(B) Frequent applications of fast-acting contact pyrethroid sprays.
(C) Spraying broad-spectrum fungicides to eliminate helper pathogens.
(D) Using soil fumigants post-harvest to kill overwintering stages.

2008

121. What is the primary limitation of systemic insecticides in preventing the transmission of non-persistent viruses?
(A) They fail to move into the phloem where vectors feed on sap.
(B) Transmission during brief probes before ingesting lethal doses.
(C) Non-persistent viruses rapidly degrade the active insecticidal compounds.
(D) They cause hyper-excitation of vectors, significantly increasing lifespan.

2009

122. Insect growth regulators (IGRs) are particularly effective in managing whitefly populations because they primarily target:
(A) The overwintering adult populations in the greenhouse.
(B) The development of nymphs into mature, reproductive adults.
(C) The migrating alate forms during long-distance flight.
(D) The pupal stage hidden entirely within the soil profile.

2007

123. The entomopathogenic fungus Beauveria bassiana controls vector populations through which mechanism of action?
(A) Adhesion of conidia to the cuticle and internal colonization.
(B) Ingestion of spores leading to midgut toxification in the vector.
(C) Secretion of volatile repellant compounds near the host plant system.
(D) Competitive exclusion of viruses on the insect stylet during feeding.

2013

124. How do seed treatments with systemic insecticides alter the transmission rates of vector-borne pathogens?
(A) They physically coat the emergent leaves, acting as a repellant.
(B) They modify the host plant DNA to make it immune to viral entry.
(C) Killing vectors that engage in sustained feeding activity.
(D) They sterilize the soil, preventing vectors from pupating correctly.

2009

125. Which phenomenon best describes an unintended negative consequence of overuse of specific systemic insecticides on vector control?
(A) Increased susceptibility of the plant to fungal infections globally.
(B) Transformation of non-persistent viruses into persistent forms in situ.
(C) Total eradication of all alternate weed hosts in the surrounding area.
(D) Development of target-site resistance or metabolic detoxification.

2015

126. Consider the following statements regarding Host Plant Resistance to vectors:
I. Antixenosis affects vector behavior, reducing landing and feeding.
II. Antibiosis negatively impacts vector biology, such as survival or fecundity.
III. Tolerance reduces the vector population significantly.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2001

127. Glandular trichomes on the surface of certain wild tomato species contribute to vector resistance primarily through which mechanism?
(A) They produce systemic antiviral compounds within the plant.
(B) Physical impediments and sticky exudates that trap small vectors.
(C) They actively phagocytize probing stylets during feeding.
(D) They reflect specific light wavelengths that repel thrips adults.

2016

128. Antibiosis in resistant host plants can lead to which direct outcome in a vector population?
(A) Immediate emigration of the entire population to neighboring fields.

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epidermal cells.
(B) The physical severing of xylem vessels by chewing mouthparts.
(C) The injection of toxic salivary secretions by feeding arthropods.
(D) Fungal toxins produced by secondary infections in wounds.

2022

95. What is the fundamental difference between phytotoxemia and a viral infection?
(A) Phytotoxemia is strictly localized, while viruses are always systemic.
(B) Phytotoxemia is caused by a chemical toxin and is non-infectious.
(C) Phytotoxemia requires a biological vector, while viruses are mechanical.
(D) Phytotoxemia only affects xylem, while viruses only affect the phloem.

2011

96. "Hopperburn," characterized by V-shaped yellowing and necrosis of leaf margins, is a classic phytotoxemic response caused by:
(A) Bemisia tabaci
(B) Frankliniella occidentalis
(C) Myzus persicae
(D) Empoasca species

2002

97. Which biochemical mechanism is responsible for the systemic effects of toxigenic saliva in disorders like psyllid yellows?
(A) Secretion of salivary effectors interfering with growth regulators.
(B) Rapid polymerization of phloem sap blocking internal transport.
(C) Direct lysis of chloroplasts within the root system of the plant.
(D) Induction of uncontrollable plant cell division leading to galls.

2023

98. Consider the following events during the induction of a localized phytotoxemic response:
I. Insect probing
II. Secretion of salivary effectors
III. Disruption of cellular metabolism
IV. Localized tissue necrosis
Which of the following represents the correct sequence of events?
(A) I - II - III - IV
(B) III - I - II - IV
(C) II - IV - I - III
(D) IV - III - I - II

2019

99. Whitefly-induced silverleaf disorder in squash is a systemic phytotoxemia directly linked to the feeding activity of:
(A) Nymphs of Bemisia tabaci biotype B.
(B) Adult Trialeurodes vaporariorum species.
(C) Eggs of Bemisia tabaci biotype Q strain.
(D) Adult greenhouse whiteflies in the field.

2008

100. Mealybug wilt of pineapple is a complex disorder historically associated with phytotoxemia, but recent research also implicates:
(A) Latent fungal endophytes activated by the toxic mealybug saliva.
(B) Nematode-transmitted tobraviruses found in the surrounding soil.
(C) An imbalance in soil micronutrients exacerbated by insect feeding.
(D) Ampeloviruses known as Pineapple mealybug wilt-associated viruses.

2010

101. Why does recovery from true phytotoxemia typically occur when the feeding arthropods are removed or eliminated?
(A) The plant rapidly produces specific virus-neutralizing antibodies.
(B) Cessation of toxin supply allows recovery mechanisms to restore function.
(C) The remaining internal toxins evaporate through the plant stomata.
(D) Beneficial predators inject counter-toxins into the plant system.

2018

102. What climatic factor most significantly dictates the population dynamics and migration peaks of aphid vectors in Northern India?
(A) High mid-summer UV radiation levels in the region.
(B) Continuous monsoon rains preventing vector flight.
(C) Spring temperature fluctuations driving alate formation.
(D) Deep winter freezing temperatures in the north.

2018

103. The sudden outbreaks of vector-borne epidemics often correlate with the vector's development of:
(A) A new mode of mechanical transmission for pathogens.
(B) Non-functional wings forcing them to remain on single crops.
(C) Complete independence from any alternate

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(A) It initiates sustained feeding but fails to reproduce.
(B) It probes briefly and then abandons the plant without settling.
(C) It alters its feeding to exclusively consume xylem sap.
(D) It regurgitates its stomach contents to detoxify the plant surface.

2002

138. The integration of transgenic crops expressing vector-targeting RNAi with traditional cultural methods represents an example of:
(A) Eradication
(B) Integrated Pest Management (IPM)
(C) Biological control
(D) Quarantine

2003

139. In vector transmission, what is meant by the term "bimodal transmission"?
(A) A vector exhibits both non-persistent and persistent traits.
(B) A vector can acquire the pathogen from both roots and shoots.
(C) A pathogen can be transmitted by two different orders of insects.
(D) A single vector can simultaneously transmit a fungus and a bacterium.

2008

140. Consider the following statements regarding persistent-propagative viruses:
I. They cross both the midgut and salivary gland barriers.
II. They induce cytopathology in vector tissues.
III. They possess a very short latent period of just a few hours.
IV. They often overwinter within the vector population itself.
Which of the above statement(s) is/are INCORRECT?
(A) I and III
(B) II and IV
(C) I, II and IV
(D) III

2009

141. Why are early-instar nymphs often better acquirers of circulative viruses than adult vectors?
(A) Their salivary glands are fully exposed to the external environment.
(B) They lack the capacity to probe deeply into phloem tissues.
(C) Their symbiotic gut bacteria aggressively assist viral entry.
(D) Midgut barriers may be more permeable to viral transit.

2015

142. What is the role of endosymbionts like Buchnera aphidicola in aphid biology relating to viral transmission?
(A) They produce structural components for viral capsids.
(B) They directly attack non-persistent viruses, rendering aphids immune.
(C) Chaperonins like GroEL protect luteoviruses in the hemolymph.
(D) They secrete enzymes that degrade plant phloem, aiding penetration.

2012

143. Which technique is most appropriately used to track the real-time probing and feeding behavior of vectors like aphids and leafhoppers on plant tissues?
(A) Polymerase Chain Reaction (PCR)
(B) Electrical Penetration Graph (EPG)
(C) Enzyme-Linked Immunosorbent Assay (ELISA)
(D) Transmission Electron Microscopy (TEM)

2001

144. In EPG (Electrical Penetration Graph) waveforms, what does specific waveform indicating "phloem salivation" typically correlate with in epidemiological terms?
(A) The loss of non-persistent viruses from the stylet during probing.
(B) The ingestion and acquisition of xylem-limited bacteria from vessels.
(C) The mechanical severing of the epidermal cell wall by the stylet.
(D) Inoculation moment for persistent-circulative viruses.

2003

145. What happens to the transmission efficiency of a non-persistent virus if the aphid vector is forced to feed continuously for several hours on an infected plant?
(A) Efficiency decreases as virus is washed off the stylet.
(B) Efficiency dramatically increases due to higher viral accumulation.
(C) The virus undergoes a transformation into a persistent state.
(D) The virus induces mortality in the feeding

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Assertion (A): Adjusting the sowing dates of crops can effectively mitigate the impact of vector-borne diseases.
Reason (R): Altered sowing dates disrupt the synchrony between the vulnerable seedling stage of the crop and the peak migration period of viruliferous vectors.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2022

113. Reflective mulches, such as silver or aluminum-coated plastics, protect young plants from non-persistent viruses primarily by:
(A) Reflecting ultraviolet light to disorient incoming vectors.
(B) Releasing volatile toxins that repel vectors from the field.
(C) Generating intense heat that kills resting insects on the soil.
(D) Providing a physical barrier that covers the entire plant canopy.

2019

114. How do barrier crops function as a cultural management tool against non-persistently transmitted viruses?
(A) They attract the vectors and provide a substrate for lethal viruses.
(B) They produce systemic chemicals that translocate to confer resistance.
(C) Probing vectors lose the retained virus on their stylets.
(D) They physically entangle the wings of alate vectors during flight.

2008

115. To be effective, a barrier crop used against aphid-transmitted non-persistent viruses must essentially be:
(A) A non-host for the specific virus being managed.
(B) Highly susceptible to the target virus.
(C) Shorter in height than the main crop.
(D) Capable of supporting heavy aphid reproduction.

2012

116. The use of insect-proof exclusion netting in greenhouses specifically relies on tailoring the mesh size to:
(A) The wingspan of the largest local predator in the greenhouse.
(B) The diameter of the viral particles being transmitted to plants.
(C) The droplet size of standard chemical sprays used for control.
(D) The maximum body width of the target vector species.

2022

117. Which of the following is a potential disadvantage of relying solely on physical exclusion netting in hot climates?
(A) Increased ventilation leading to excessive plant transpiration rates.
(B) Reduction in air circulation leading to elevated internal humidity.
(C) Direct degradation of the netting by plant-produced enzymes.
(D) Enhanced transmission efficiency of soil-borne pathogens in the area.

2008

118. Among cultural controls, "roguing" refers to the practice of:
(A) Using trap crops to divert vector feeding away from the crop.
(B) Applying reflective mulches to the soil surface to deter landing.
(C) Removing infected plants to eliminate internal inoculum.
(D) Rotating the field with non-host leguminous crops during off-season.

2016

119. Match the vector management strategy with its specific action mechanism:
List I: (Vector Management Strategy)
P. Systemic insecticides
Q. Insect growth regulators (IGRs)
R. Reflective mulches
S. Entomopathogenic fungi
List II: (Action Mechanism)
1. Disrupts molting and development of immatures
2. Directly kills vectors via cuticular penetration and internal colonization
3. Translocates within plant sap to kill feeding vectors
4. Visually deters vector landing
(A) P-3, Q-1, R-4, S-2
(B) P-2, Q-3, R-1, S-4
(C) P-3, Q-4, R-1, S-2
(D) P-1, Q-2, R-4, S-3

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dependent)
(A) P-2, Q-3, R-1, S-4
(B) P-3, Q-1, R-4, S-2
(C) P-2, Q-4, R-1, S-3
(D) P-1, Q-2, R-3, S-4

2018

155. Which of the following is considered the absolute prerequisite for the initial acquisition of a phloem-limited, persistently transmitted virus by a vector?
(A) Secretion of a solid salivary sheath reaching the vascular tissue.
(B) Mechanical disruption of the plant cuticle by chewing mouthparts.
(C) Passive uptake via stomatal openings on the surface of the leaf.
(D) Pre-feeding starvation for at least 24 hours prior to acquisition.

2019

156. The vector competence of a specific Bemisia tabaci biotype depends largely on its ability to:
(A) Physically destroy plant tissue during the feeding process.
(B) Survive extreme freezing temperatures during overwintering stages.
(C) Support endosymbionts that protect the virions in the hemolymph.
(D) Switch rapidly between chewing and piercing-sucking mouthparts.

2002

157. Which modern molecular technique is increasingly used to identify specific viral retention sites within the microscopic anatomy of a vector?
(A) Simple brightfield microscopy of stained vector tissues.
(B) Polymerase Chain Reaction (PCR) on ground vector samples.
(C) Gas Chromatography-Mass Spectrometry (GC-MS) for volatiles.
(D) Immunofluorescence labeling coupled with Confocal Microscopy.

2013

158. In the context of RNAi targeting vector genes, what represents the primary delivery challenge for field application?
(A) Finding a suitable target gene that causes vector mortality.
(B) Preventing the dsRNA from converting into DNA inside the plant.
(C) Ensuring environmental stability and efficient uptake of dsRNA.
(D) Stopping the RNAi from creating new, highly virulent viral strains.

2010

159. Consider the following statements concerning the epidemiology and control of vector-borne plant diseases:
I. Epidemiology studies the interplay of the pathogen, vector, host, and environment.
II. Altering sowing dates is a form of chemical control.
III. Exclusion netting reduces physical access of vectors to the crop.
IV. Weeds frequently act as reservoirs bridging disease cycles.
V. Resistance breeding only focuses on the pathogen, not the vector.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, III and IV
(C) II, III and V
(D) I, IV and V

2023

160. What is a primary objective of utilizing barrier crops in the integrated management of vector-borne diseases?
(A) To provide a secondary cash crop that generates higher income for the farm.
(B) To aggressively spread entomopathogenic fungi to all neighboring farms.
(C) To increase ambient temperature, exceeding the viral thermal death point.
(D) To act as a sink that cleanses probing vectors of non-persistent viruses.

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74. (B) Cytopathological effects reducing vector output.
While phytoplasmas are obligate pathogens of their insect vectors, their multiplication can induce measurable cytopathological effects. These internal infections may lead to a reduction in the vector's overall fitness, lifespan, or reproductive capacity. Such deleterious impacts contrast with the more benign relationships seen in non-propagative transmission, where the pathogen does not multiply and has minimal direct effect on the insect's health.

75. (A) The need for an initial acquisition feeding by offspring.
Transovarial transmission of phytoplasmas allows the pathogen to bypass the critical epidemiological bottleneck of the initial acquisition feeding by the offspring. When the bacteria are passed from the mother to the eggs, the newly hatched nymphs are already viruliferous. This ensures that the next generation of vectors can immediately begin spreading the disease without having to first locate an infected.

76. (C) Midgut epithelial cells
For spiroplasmas to achieve a systemic infection within their insect vector, they must successfully traverse the midgut epithelial cells. This crossing is a critical step in the persistent-propagative transmission cycle, as it allows the bacteria to enter the hemocoel and subsequently migrate to the salivary glands. This process often involves specific receptor-mediated interactions between the pathogen and the insect's gut.

77. (C) A is true but R is false.
Leafhoppers are the primary vectors for most known plant pathogenic phytoplasmas, reflecting a highly evolved and specific biological relationship. However, the assertion that only leafhoppers possess the required midgut receptors is false, as other hemipteran groups like psyllids and planthoppers are also capable of transmitting certain phytoplasmas. This indicates that while specialized, the mechanisms for transmission exist across families.

78. (B) Carried as transient surface contamination.
Active mechanical transmission implies that a pathogen is carried by a vector as transient surface contamination rather than through an internal, biological cycle. In this mode, the pathogen is typically picked up on the insect's mouthparts, legs, or body during feeding or contact with an infected source. It is then delivered to a healthy host without requiring replication or internal movement.

79. (B) Brief, superficial probes in the epidermis.
Stylet-borne viruses that are transmitted non-persistently are most efficiently acquired during the brief, superficial probing phase of aphid behavior. During these probes, the insect inserts its stylets into the epidermal cells to sample the host plant. This short contact time is sufficient for virions to adhere to the stylet tips, which are then quickly inoculated into the next plant.

80. (D) A protein bridging the virion to the insect stylet.
In non-persistent transmission, the term "helper component" refers to a virus-encoded protein that acts as a molecular bridge. It simultaneously binds to the viral capsid and to specific receptors on the inner surface of the insect vector's maxillary stylets. This interaction is essential for the retention of the virus during transit and its subsequent release into a new host plant.

81. (A) Non-persistent and semi-persistent
The loss of infectivity following the molting process is a defining characteristic of both non-persistent and semi-persistent transmission. In these modes, the pathogen is retained either on the external surfaces of the mouthparts or within the cuticular lining of the foregut. When the insect sheds its exoskeleton and foregut lining during a molt, the entire population of pathogens is removed.

82. (C) Semi-persistent viruses require longer acquisition time.
Semi-persistent transmission differs from the non-persistent mode primarily in the required duration for acquisition and inoculation. Semi-persistent viruses typically necessitate longer feeding periods, often ranging from hours to days, to achieve successful transmission. Additionally, these viruses are retained within the vector for a longer period, although they still do not circulate through the hemolymph or replicate inside the insect's body.

83. (A) The inner lining of the foregut.
For semi-persistent viruses, the primary anatomical site of retention within aphid vectors is the inner cuticular lining of the foregut. Unlike

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puncture the surface of plant cells, then utilize their maxillary stylets to form a tube for sucking up the released cellular contents. This feeding mechanism is vital for the acquisition and transmission of various pathogens, including the economically significant Tospoviruses.

10. (B) The midgut epithelial cells
After ingestion, persistent-circulative viruses must bypass the midgut epithelial cells to enter the vector's hemocoel. This transit often involves receptor-mediated endocytosis at the apical membrane and exocytosis at the basal membrane. Successfully crossing this cellular barrier is a prerequisite for the virus to reach the hemolymph and eventually the salivary glands, enabling the vector to become infective for transmission.

11. (A) Gross mechanical transmission during feeding via regurgitation.
Insects with chewing mouthparts, such as beetles, typically transmit pathogens through gross mechanical means. During feeding, these insects cause significant tissue damage and often regurgitate digestive fluids onto the wounded plant surface. If these fluids contain viable pathogens acquired from previous feeding on infected hosts, the mechanical injury provides a direct entry point, facilitating the spread of the disease.

12. (C) Aphids
Aphids exhibit a specialized feeding behavior involving the secretion of a gelling saliva that hardens to form a salivary sheath. This structure surrounds the stylets as they penetrate between plant cells, providing mechanical support and protecting the insect from plant defense responses. The sheath's path eventually leads the stylets to the phloem, which is the primary site for nutrient acquisition.

13. (D) Non-persistent
Non-persistent transmission often utilizes a virus-encoded helper component protein to facilitate the temporary attachment of virions to the vector's mouthparts. This protein acts as a molecular bridge, binding simultaneously to the viral capsid and specific receptor sites on the inner surface of the aphid's maxillary stylets. This interaction ensures the virus is retained during transit and released during subsequent probing.

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14. (A) P-2, Q-1, R-3, S-4
Plant viruses utilize diverse strategies for vector-mediated spread. Potyviruses are classically non-persistent, while Luteoviruses require circulation through the vector's body. Caulimoviruses are typically transmitted in a semi-persistent manner, involving retention in the foregut. Enamoviruses exhibit a complex persistent-circulative mechanism that is often dependent on specific helper proteins for successful movement and transmission, highlighting the specialized nature of these interactions.

15. (B) Non-persistent viruses in the epidermal tissue.
Probing refers to the brief, superficial insertions of aphid stylets into the epidermal cells of a plant. This behavioral phase is primarily used by the insect to assess host suitability. However, it also facilitates the rapid acquisition and inoculation of non-persistent viruses. Because these viruses are carried on the stylet tips, these short-duration probes are sufficient for efficient transmission.

16. (D) Yellow-green light reflectance
During the host-seeking phase, aphids are strongly attracted to light reflected in the yellow-green part of the spectrum. This visual preference helps them locate healthy, vigorously growing plants from a distance. Many vector management strategies, such as the use of yellow sticky traps or reflective mulches, exploit this behavioral trait to either monitor populations or disrupt the landing process.

17. (A) Myzus persicae
Myzus persicae, commonly known as the green peach aphid, is recognized as one of the most significant and polyphagous insect vectors globally. It is capable of transmitting hundreds of different plant viruses across numerous botanical families. Its broad host range, high reproductive potential, and efficiency in both non-persistent and persistent transmission make it a primary target for agricultural pest management.

18. (C) They are retained on the inner surface of the maxillary stylets.
Non-persistent viruses do not require a latent period because they are carried externally on the inner surfaces of the vector's maxillary stylets. Since the virus does not need to enter the insect's body, circulate through the hemolymph, or

reach the salivary glands, it can be transmitted immediately after acquisition. This stylet-borne mechanism allows for extremely rapid spread within crops.

19. (A) Luteoviruses undergo massive replication within the aphid midgut prior to transmission.
Luteoviruses are characterized by a persistent-circulative, non-propagative transmission mechanism. This means that while the virus must cross the midgut and salivary gland barriers to be transmitted, it does not undergo replication within the aphid vector's tissues. The internal viral titer remains dependent on the amount acquired during feeding, distinguishing it from propagative viruses that multiply within their hosts.

20. (D) RTSV acting as a necessary helper for the acquisition of RTBV.
The transmission of Rice tungro disease involves a unique synergistic relationship between two distinct viruses. Rice tungro spherical virus (RTSV) can be transmitted independently by leafhopper vectors, but it is also required as a helper for the acquisition of Rice tungro bacilliform virus (RTBV). Without the presence of RTSV, the vector is unable to successfully acquire and transmit the virus.

21. (B) II and III
Mollicutes, including phytoplasmas and spiroplasmas, are characterized by a persistent-propagative transmission mechanism in their leafhopper vectors. These pathogens must multiply within the vector's internal tissues, such as the midgut, hemolymph, and salivary glands, before transmission can occur. Consequently, they require a significant latent period after acquisition, during which the pathogen titer increases sufficiently for the vector to become infectious.

22. (C) Rice yellow dwarf phytoplasma
The leafhopper genus Nephotettix, particularly species like Nephotettix virescens, is the primary vector for Rice yellow dwarf phytoplasma. This fastidious pathogen is restricted to the phloem of the rice plant and is transmitted in a persistent-propagative manner. The vector must feed on infected plants for a sufficient period to acquire the phytoplasma, which then multiplies internally before inoculation.

23. (D) Tenuiviruses
Planthoppers, belonging to the family Delphacidae, are specifically known for their role as vectors of Tenuiviruses, such as Rice grassy stunt virus. This group of viruses is distinct from those typically carried by leafhoppers in the family Cicadellidae. The interaction between planthoppers and tenuiviruses is often persistent-propagative, frequently involving transovarial transmission, which allows the virus to persist.

24. (A) Xylem-limited bacteria such as Xylella fastidiosa.
Sharpshooters are specialized leafhoppers that feed exclusively on xylem sap. Due to this unique feeding niche, they are the primary vectors for xylem-limited bacterial pathogens like Xylella fastidiosa. The bacteria colonize the insect's foregut, forming biofilms that are eventually shed into the plant's water-conducting vessels during feeding. This leads to vascular blockages, resulting in symptoms like leaf scorch.

25. (B) The pathogen traverses the hemocoel and replicates before reaching the glands.
Phytoplasmas require a prolonged latent period within their leafhopper vectors because they must undergo a complex internal journey. After ingestion into the midgut, the bacteria must cross the gut epithelium to enter the hemocoel. From there, they migrate to and multiply within the salivary glands. This replication and movement take time, ensuring the vector only becomes capable of transmission later.

26. (B) Sogatella furcifera - Wheat streak mosaic
While many hoppers are specialized vectors, the pairing of Sogatella furcifera with Wheat streak mosaic is incorrect. Wheat streak mosaic virus is primarily transmitted by the wheat curl mite, an eriophyid mite, rather than a planthopper. In contrast, Sogatella furcifera is a known vector for pathogens like Rice black-streaked dwarf virus, highlighting the high degree of specificity in relationships.

27. (B) Biotype B (MEAM1)
Within the Bemisia tabaci species complex, Biotype B, also known as Middle East-Asia Minor 1 (MEAM1), is recognized as the most invasive and agriculturally damaging. This biotype possesses a broad host range, high reproductive rates, and significant resistance to many insecticides. Its ability to transmit

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numerous begomoviruses efficiently has led to devastating crop losses in many tropical and subtropical regions.

28. (A) Midgut → Hemolymph → Primary salivary gland
Begomoviruses follow a circulative route within their whitefly vectors. After the insect feeds on an infected plant, the virus is ingested into the midgut. From there, virions cross the intestinal wall to enter the hemolymph. They are then transported to the primary salivary glands, where they must cross additional membranes before being released into the saliva for inoculation into hosts.

29. (D) Persistent-circulative
Begomoviruses, which cause significant diseases like Cotton leaf curl, are transmitted by the whitefly Bemisia tabaci in a persistent-circulative, non-propagative manner. The virus is retained within the vector for several weeks but does not replicate inside the insect's tissues. This mechanism involves specific interactions with vector proteins and barriers, ensuring the virus remains viable as it moves through the system.

30. (C) GroEL homologue produced by secondary endosymbionts.
In whitefly vectors, a GroEL homologue protein produced by secondary endosymbionts plays a vital role in viral transmission. This chaperone protein interacts with begomoviruses in the hemolymph, protecting them from degradation by the insect's immune system. This protection ensures that a sufficient titer of viable virions reaches the salivary glands, which is essential for the effective inoculation of healthy plants.

31. (B) Semi-persistent
Criniviruses, such as Tomato chlorosis virus, are transmitted by whitefly vectors in a semi-persistent manner. Unlike circulative viruses, they do not enter the vector's hemolymph or salivary glands. Instead, they are retained within the foregut or on the mouthparts for a duration ranging from hours to a few days. Consequently, these viruses are lost when the vector insect molts.

32. (D) Extremely rare or absent
In the context of begomovirus epidemiology, transovarial transmission—the passage of the virus from the female vector to its offspring—is generally considered to be extremely rare or entirely absent. Most whiteflies must acquire the virus anew by feeding on an infected plant after they hatch. This lack of vertical transmission means that the disease spread depends heavily on adult vector movement.

33. (A) Visual attraction to yellow-green and gustatory probing.
Whiteflies utilize a combination of visual and gustatory cues to locate and select their host plants. They are strongly attracted to the yellow-green part of the light spectrum, which helps them identify potential hosts from a distance. Upon landing, they perform brief gustatory probes to assess the chemical composition of the leaf surface and internal tissues before initiating sustained feeding.

34. (C) It is exclusively acquired during the first and second larval instars.
A unique characteristic of Tospovirus transmission is that the virus can only be acquired by thrips during their first or second larval instars. While the virus can be maintained as the insect matures through the pupal stage to adulthood, adult thrips that feed on an infected plant for the first time are incapable of becoming vectors for the pathogen.

35. (B) II and IV
Tospoviruses, such as Tomato spotted wilt virus, are transmitted in a persistent-propagative manner, meaning they replicate within the thrips vector. Furthermore, transmission is strictly linked to larval acquisition; adults that encounter the virus for the first time cannot transmit it. Therefore, descriptions characterizing the mechanism as non-persistent or suggesting immediate adult acquisition are incorrect, as they contradict fundamental biology.

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36. (D) Epidermal and mesophyll cells
Thrips employ a "punch and suck" feeding strategy, where they use their mouthparts to rupture the cell walls of epidermal and mesophyll tissues. They then ingest the released cytoplasm and cellular contents. During this process, pathogens like Tospoviruses can be acquired from or inoculated into these superficial cells. This destructive feeding behavior differs from the more precise vascular feeding.

37. (B) The retention of the pathogen through successive developmental molts.
Transstadial transmission refers to the ability of a pathogen to persist within a vector across different developmental stages or molts. In thrips, this is essential for Tospovirus spread, as the virus acquired during the larval stages must remain viable through the pupal phase and into the adult stage. This ensures the emerging adult remains viruliferous and capable of infecting new host plants.

38. (C) A temporary connection between the midgut and salivary glands.
In larval thrips, a specialized anatomical connection exists between the midgut and the salivary glands. This temporary structural proximity allows Tospoviruses to move efficiently from the site of ingestion to the site of inoculation. As the insect matures, this connection is often lost, which helps explain why the virus must be acquired during the larval instars to ensure adult transmission.

39. (D) Diaphorina citri
Citrus greening disease, or Huanglongbing (HLB), is caused by the bacterium Candidatus Liberibacter asiaticus and is primarily vectored by the Asian citrus psyllid, Diaphorina citri. This insect is a phloem-feeder that acquires the pathogen during sustained feeding on infected citrus trees. The psyllid's efficient transmission and widespread distribution have made it a major threat to citrus production globally.

40. (A) Through prolonged phloem ingestion from infected citrus plants.
The psyllid vector acquires the Citrus greening pathogen through prolonged feeding on the phloem of infected host plants. Since the bacteria are restricted to the sieve elements, the insect must penetrate deep into the plant tissue to ingest a sufficient quantity of the pathogen. This acquisition period is followed by a latent phase during which the bacteria multiply and circulate.

41. (B) Persistent-propagative
Psyllids transmit phloem-restricted fastidious bacteria, such as Candidatus Liberibacter, in a persistent-propagative manner. This classification indicates that the bacteria not only circulate within the vector's body but also actively multiply within its tissues, including the salivary glands. Once the vector becomes viruliferous, it can typically transmit the pathogen for the remainder of its life, contributing to the rapid disease spread.

42. (A) Both A and R are true and R is the correct explanation of A.
Management of Citrus greening disease is centered on controlling the psyllid vector populations. This strategy is necessitated by the fact that the causal bacteria, Candidatus Liberibacter, are currently unculturable in vitro, which has hindered the development of effective chemical cures for infected trees. Consequently, preventing the spread of the pathogen by managing the insect vector remains the most viable approach.

43. (A) Potato zebra chip
Potato zebra chip is a significant disease of solanaceous crops caused by the bacterium Candidatus Liberibacter solanacearum. It is primarily transmitted by the potato psyllid, Bactericera cockerelli. The disease manifests as dark stripes in fried potato chips, which are caused by the accumulation of sugars and phenolics in the vascular tissues, rendering the affected tubers unmarketable and causing losses.

44. (C) Jumping hind legs and rigid wings.
Psyllids are morphologically distinguished from aphids by their specialized jumping hind legs and relatively rigid wings. While both are hemipterans with piercing-sucking mouthparts, these physical adaptations contribute to the psyllid's distinct movement and dispersal behaviors. These differences, along with their specialized host ranges and life cycles, influence their specific roles as vectors for various fastidious plant pathogens, including HLB.

45. (D) Comovirus, Tymovirus, and Sobemovirus
Leaf-feeding beetles and weevils are known vectors for specific groups of plant viruses, most notably those in the genera Comovirus, Tymovirus, and Sobemovirus. These viruses are often characterized by high stability and high concentrations within the host plant tissues. Their transmission by beetles is typically mechanical in nature, facilitated by the insect's chewing feeding behavior and the presence of virions.

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46. (C) Regurgitation of digestive fluids containing viable virus particles.
The transmission of plant viruses by leaf-feeding beetles is largely dependent on the regurgitation of digestive fluids during the feeding process. As the beetle chews on an infected leaf, it ingests virions, which can persist in its gut. When the beetle moves to a healthy plant and initiates feeding, it regurgitates virus-laden fluids into the fresh wound, facilitating infection.

47. (B) Massive tissue destruction prevents precise delivery to the phloem.
Beetles are ineffective vectors for phloem-limited viruses like Luteoviruses because their chewing feeding habit causes massive and indiscriminate tissue destruction. These viruses require precise deposition into the intact sieve elements of the phloem to initiate an infection. The gross mechanical damage inflicted by beetles prevents this specialized delivery, unlike the delicate probing behavior of piercing-sucking insects like aphids.

48. (D) Stable survival of the virus in the hemolymph for several days.
The retention of viruses in beetle vectors is often facilitated by the stable survival of the virus within the insect's hemolymph. While the initial transmission may involve regurgitation, some viruses can cross the gut wall and circulate internally for several days without replication. This internal reservoir allows the beetle to remain infective and transmit the virus to multiple healthy plants.

49. (A) P-2, Q-3, R-4, S-1
Different insects act as mechanical vectors for various pathogens. Flea beetles are associated with Tymoviruses, while honey bees incidentally spread floral-infecting bacteria like Erwinia amylovora. Aphids are famous for the rapid spread of non-persistent epidermal viruses during brief probes. Bark beetles play a critical role in carrying fungal spores between woody hosts, highlighting the diversity of mechanical transmission pathways in ecosystems.

50. (C) Mechanical transfer of ooze on mouthparts.
Bacterial wilt, caused by pathogens like Ralstonia solanacearum, can be disseminated incidentally by various insects through the mechanical transfer of bacterial ooze. This ooze, containing high concentrations of the pathogen, can adhere to the insect's mouthparts, legs, or body surfaces during contact with infected plants. When the insect moves to a healthy host, the bacteria are successfully transferred.

51. (A) Blossoms and floral tissues
Flies and bees are primarily associated with the incidental transmission of diseases affecting blossoms and floral tissues. As these insects visit flowers for nectar and pollen, they can pick up pathogens such as bacteria or fungal spores from infected floral parts. These agents are then mechanically transported to the nectaries or stigmatic surfaces of healthy flowers, spreading floral diseases.

52. (D) Bacteria from ooze adhere to the bee's body and are transferred.
Fire blight, caused by the bacterium Erwinia amylovora, is frequently spread by bees during their foraging activities. The bacteria produce a sticky ooze on the surface of infected blossoms or cankers. As bees visit these sites, the bacteria adhere to their bodies and legs. When the bees then visit healthy flowers, they inadvertently transfer the inoculum, leading to widespread infections.

53. (B) Frugivorous flies and sap beetles visiting wounded fruit.
The fungal pathogen Monilinia fructicola, which causes brown rot in stone fruits, is often disseminated by frugivorous flies and sap beetles. These insects are attracted to wounded or overripe fruit, where they come into contact with fungal spores. As they move between fruits and trees, they carry these spores on their bodies, facilitating the rapid spread of the disease.

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54. (C) Environmental contamination and physical contact.
Incidental mechanical transmission by flies and bees is characterized by a lack of high vector specificity and the absence of a latent period. This process relies on environmental contamination and simple physical contact between the insect and the pathogen. The transmission occurs purely through the surface carriage of inoculum, such as bacterial ooze or fungal spores, from an infected source.

55. (D) The nectaries and stigmatic surfaces
In floral tissues, the nectaries and stigmatic surfaces are the most vulnerable entry points

for pathogens. These areas often lack the heavy cuticular protection found on petals and other plant parts, providing a direct route for bacteria or fungi to enter the plant's internal systems. Insects like bees and flies frequently contact these surfaces, facilitating the mechanical inoculation of diseases.

56. (A) I and III
Mites belong to the class Arachnida, not Insecta, which is a fundamental taxonomic distinction. Furthermore, while certain mites are important vectors, such as eriophyids for Pigeonpea sterility mosaic virus, tetranychid or spider mites are not recognized as major vectors of Luteoviruses. Those viruses are primarily transmitted by aphid species in a persistent-circulative manner, highlighting the specialized relationships between arthropods.

57. (B) Aceria cajani
Pigeonpea sterility mosaic disease is a serious threat to pigeonpea cultivation and is caused by the Pigeonpea sterility mosaic virus. This virus is specifically transmitted by the eriophyid mite Aceria cajani. These microscopic mites are easily dispersed by wind and can spread the virus rapidly within a crop. The virus-vector relationship is highly specific, as other mite species cannot transmit it.

58. (B) Tritimovirus (family Potyviridae)
Wheat streak mosaic virus is the type species of the genus Tritimovirus within the family Potyviridae. It is a well-known plant pathogen primarily transmitted by the wheat curl mite, Aceria tosichella. This virus causes significant yield losses in wheat and other cereal crops by inducing characteristic streaking and mosaic symptoms on the leaves, often leading to stunted growth and reduced production.

59. (A) Passive transport via wind currents
Eriophyid mites are extremely small and lack wings, which limits their active movement. Their primary mechanism for long-distance dissemination is passive transport via wind currents. These mites can be lifted from the leaf surface and carried over significant distances to new host plants. This wind-borne dispersal is a critical factor in the epidemiology of various plant viruses they transmit.

60. (C) The viruses they transmit are usually restricted to one or a few related plant species.
The extraordinarily high degree of host specificity exhibited by eriophyid mites significantly influences the epidemiology of the viruses they transmit. Because these mites are often restricted to a single plant genus or species, the associated viruses typically have narrow host ranges. This specificity limits the reservoir potential of surrounding vegetation and dictates the spatial patterns of disease spread in agricultural landscapes.

61. (D) Citrus (e.g., Citrus leprosis virus).
Brevipalpus mites, also known as false spider mites, are historically significant for their role in transmitting several important plant viruses. One of the most economically devastating is Citrus leprosis virus, which affects citrus production in many parts of the world. These mites act as persistent vectors, carrying the virus and causing localized lesions on the fruit, leaves, and stems of trees.

62. (C) Storing and transporting fungal spores.
Mycangia are specialized anatomical structures found in certain insect vectors, such as bark and ambrosia beetles. These organs are specifically evolved for the storage and transportation of fungal spores. By housing the fungi internally, the insect ensures a constant supply of inoculum, which is essential for colonizing new host trees. This mutualistic relationship facilitates both fungal dispersal and beetle nutrition.

63. (C) II - I - III - IV
The life cycle of the Dutch elm disease pathogen involves a sequence starting with larvae pupating in the galleries of dead trees. Adult beetles then emerge from the wood, carrying fungal spores on their bodies. These beetles fly to healthy elm trees to feed on twig crotches, thereby inoculating the host. Finally, the fungus spreads systemically through the xylem vessels.

64. (D) Eriophyid mites assisting fungal entry.
Mango malformation disease is a complex disorder strongly associated with the interaction between eriophyid mites and fungal pathogens, primarily species of Fusarium. The mites damage the floral and vegetative tissues through their feeding activity, creating entry points for the fungus. This synergistic relationship leads to the characteristic malformed growth of the mango

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inflorescences and shoots, significantly impacting fruit production.

65. (A) To deposit spores directly into susceptible woody tissues.
In many fungus-vector associations, such as those involving bark beetles, the primary role of the insect is to deposit spores directly into susceptible woody tissues. These beetles bore through the bark and into the tree's vascular system to create galleries for reproduction. During this process, they introduce the fungal inoculum, which then colonizes the host, often leading to systemic infection.

66. (C) The beetle introduces the fungus into its galleries.
The Laurel wilt pathogen, Raffaelea lauricola, is established in new host trees by the redbay ambrosia beetle. This beetle carries the fungus within specialized mycangia and introduces it into the galleries it excavates in the tree's wood. The fungus serves as a food source for the beetle's larvae while simultaneously colonizing the host's vascular system, causing rapid and often fatal wilt.

67. (A) Mutualistic symbiosis for food and transport.
The relationship between the fungus Ophiostoma novo-ulmi and elm bark beetles is a classic example of mutualistic symbiosis. The beetle provides a reliable mechanism for the fungus to disperse and reach new, healthy trees. In return, the fungus colonizes the host tissue and may serve as a nutritional supplement for the beetle's developing larvae, highlighting the interdependent nature of organisms.

68. (D) Xylella fastidiosa
Xylella fastidiosa is a xylem-limited bacterium that relies on the formation of biofilms in the foregut of sharpshooter leafhoppers for its retention and transmission. These biofilms allow the bacteria to adhere to the chitinous lining of the insect's mouthparts, resisting being washed away by the rapid flow of xylem sap. The bacteria are subsequently released and inoculated into host plants.

69. (B) Because it binds to the foregut cuticle and is lost when the vector molts.
The transmission of Xylella fastidiosa is considered non-persistent or semi-persistent because the bacteria remain restricted to the cuticular lining of the vector's foregut. Since they do not cross into the hemolymph or salivary glands, the entire bacterial population is shed and lost when the insect molts its exoskeleton. Consequently, the vector must re-acquire the pathogen after every stage.

70. (B) I and II
Biofilms play a critical role in bacterial transmission by protecting the pathogen from the vector's digestive enzymes and ensuring its stable retention. During the feeding process, the disruption of these biofilms can release planktonic bacterial cells, which are then inoculated into the plant. Unlike internal pathogens, these biofilms are typically formed in the foregut rather than the hindgut, facilitating immediate delivery.

71. (D) Scorch, wilting, and stunting
Bacterial pathogens transmitted by xylem-feeding insects, such as sharpshooters, typically cause diseases that manifest as scorch, wilting, and stunting. These symptoms are a direct result of the bacteria colonizing and multiplying within the plant's water-conducting vessels. The resulting vascular blockages and biofilm formation impede the flow of water and nutrients, leading to physiological stress and characteristic leaf symptoms.

72. (A) They process large volumes of xylem sap.
Sharpshooters are exceptionally efficient vectors for xylem-limited bacteria because they process extraordinarily large volumes of xylem sap. Since xylem fluid is nutrient-poor, these insects must ingest and excrete vast quantities to meet their nutritional needs. This high-volume throughput increases the probability of acquiring low-titer bacteria from infected plants and ensures the effective inoculation of the pathogen into new host plants.

73. (B) Phytoplasmas must replicate within the vector's organs.
The transmission of phytoplasmas differs from that of surface-contaminating bacteria because phytoplasmas must enter and replicate within the vector's internal organs. After acquisition, they move through the gut wall into the hemolymph and eventually colonize the salivary glands. In contrast, surface bacteria are typically carried mechanically on the mouthparts or within the foregut, without the need for internal replication.

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ANSWERS

1. (A) The time from pathogen acquisition until the vector is capable of transmission.
The latent period represents the interval following the acquisition of a pathogen by a vector during which it cannot yet transmit the agent to a new host. During this phase, the pathogen may move through the vector's body, penetrate various tissues, or replicate until it reaches the salivary glands, eventually rendering the insect capable of successful inoculation.

2. (C) Retention time
Retention time defines the period during which a vector remains capable of transmitting a pathogen after moving away from an infected source. This duration varies significantly based on the transmission mechanism, ranging from minutes in non-persistent viruses to the entire lifespan in persistent ones, and reflects how long the pathogen remains viable and accessible within the vector's biological system.

3. (A) Feeding on a healthy host plant to ensure successful pathogen transmission.
The inoculation access period is the specific duration a viruliferous vector must spend feeding on a healthy susceptible host to ensure the successful delivery of a pathogen. This phase is critical in epidemiology as it determines the minimum contact time required for infection to occur, influenced by the vector's feeding behavior and the pathogen's specific tissue localization.

4. (B) Efficiency increases with longer feeding times up to a specific saturation point.
For persistent viruses, transmission efficiency typically demonstrates a positive correlation with the acquisition access period. Longer feeding durations on an infected source allow the vector to ingest a higher quantity of the pathogen, increasing the probability of successful infection. This efficiency eventually reaches a saturation point where further increases in feeding time do not significantly improve the overall transmission rate.

5. (B) Acquisition access period, Latent period, Inoculation access period
Biological transmission begins with the acquisition access period, where the vector feeds on an infected host to pick up the pathogen. This is followed by a latent period, during which the pathogen moves or replicates within the vector. Finally, the inoculation access period occurs when the now-infective vector feeds on a healthy host to successfully transmit the agent.

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6. (C) Persistent
Persistent transmission is characterized by the vector's ability to retain and transmit a pathogen for an extended duration, often spanning its entire adult life. Unlike non-persistent or semi-persistent modes, the pathogen in this category typically enters the vector's hemolymph and may circulate or multiply, ensuring a long-lasting supply of infectious material that does not require frequent re-acquisition from host sources.

7. (A) Both A and R are true and R is the correct explanation of A.
Phloem-limited viruses are restricted to the vascular tissues of the host plant. Vectors with piercing-sucking mouthparts, such as aphids and leafhoppers, possess specialized stylets capable of penetrating through epidermal and mesophyll layers to reach the sieve elements. This precise delivery is essential for successful inoculation, as these viruses cannot establish infection if deposited in superficial non-vascular tissues.

8. (A) Luteoviruses
In the transmission of Luteoviruses, the accessory salivary gland of the aphid vector serves as a critical internal selectivity barrier. To be transmitted, virions must move from the hemolymph across the basal lamina and plasma membrane of these glands into the salivary duct. This highly specific receptor-mediated process determines which aphid species can successfully act as vectors for particular viruses.

9. (B) Thrips
Thrips are characterized by unique rasping-sucking mouthparts, which are asymmetrical in nature. They use a single mandible to rasp or

non-persistent viruses that are carried on the stylet tips, semi-persistent viruses are ingested and bound to the esophageal or stomach walls. This internal but non-circulative localization allows the virus to remain with the vector for an extended period.

84. (A) P-3, Q-4, R-1, S-2
Viral retention characteristics vary significantly across transmission categories. Semi-persistent viruses are lost during molting, while persistent-circulative viruses remain with the vector without multiplying. Persistent-propagative viruses undergo replication within the vector's tissues, ensuring long-term infectivity. Conversely, non-persistent viruses are only retained on the stylet tips for very short durations, highlighting the diverse biological strategies employed by viruses for successful spread.

85. (B) Receptor-mediated endocytosis and exocytosis
During persistent-circulative transmission, Luteoviruses move through their aphid vectors via a highly regulated process of receptor-mediated endocytosis and exocytosis. The virions are first taken up by the epithelial cells of the midgut or hindgut and released into the hemolymph. They then follow a similar pathway to enter the salivary glands, ensuring a precise and selective transit through the internal tissues.

86. (C) Binding to symbiotic chaperonins like GroEL
Persistent-circulative viruses are protected from degradation in the vector's hemolymph by binding to specialized chaperone proteins, such as GroEL. These chaperonins are typically produced by the insect's symbiotic bacteria, such as Buchnera in aphids. This interaction shields the virions from the host's immune system, maintaining their structural integrity and infectivity as they circulate toward the salivary glands for inoculation.

87. (D) Luteoviruses
The accessory salivary gland basal lamina serves as a critical selection barrier that dictates vector specificity for Luteoviruses. Only specific viruses can successfully cross this membrane to reach the salivary duct for transmission. This highly selective interaction is a key factor in determining which aphid species are competent vectors for particular luteoviruses, illustrating the complex co-evolution between the virus and vector.

88. (A) Viral replication within the vector
Persistent-circulative transmission is fundamentally defined by the absolute absence of viral replication within the insect vector. Although the virus must circulate through the hemolymph and pass through several internal tissue barriers, its titer does not increase over time. The amount of virus available for inoculation is strictly limited by the quantity initially acquired during feeding on an infected host.

89. (B) Persistent-propagative transmission
The presence of cytopathological structures, such as viral inclusion bodies or massive aggregations of virions in vector tissues, is a definitive indicator of persistent-propagative transmission. These structures signify that the virus is actively replicating within the insect's cells, utilizing the host's machinery for its multiplication. This replication often leads to high viral titers and can sometimes cause observable physiological changes.

90. (B) Rhabdoviridae
The family Rhabdoviridae is classically recognized for its persistent-propagative transmission mechanism in both plant and insect hosts. These viruses possess a complex structure and a negative-sense RNA genome. Within the vector, they multiply in various tissues, including the gut and salivary glands, ensuring that the insect remains infective for its entire life and often enabling vertical passage of the virus.

91. (C) III
In persistent-propagative transmission, the latent period is not solely determined by the passive diffusion of virions to the salivary glands. Instead, it is dependent on the time required for the pathogen to actively replicate within various vector tissues and reach a threshold titer. This internal multiplication ensures the vector becomes highly infective, although the process may sometimes cause cytopathological damage.

92. (C) Vector offspring hatch already viruliferous without needing to feed on infected plants.
Transovarial transmission presents a major challenge for disease management because the vector offspring hatch already viruliferous. This means they do not need to feed on an infected plant to acquire the pathogen and can immediately begin spreading the disease to

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healthy crops. This vertical transmission allows the virus to persist in the vector population even in the absence of hosts.

93. (D) Spread of the pathogen from an infected parent vector to its progeny.
Vertical transmission in vector epidemiology refers exclusively to the spread of a pathogen from an infected parent vector to its progeny. This process, often achieved through transovarial passage within the eggs, allows the pathogen to persist through successive generations of the insect. It is a critical factor in the survival and long-term maintenance of certain propagative viruses and fastidious bacteria.

94. (C) The injection of toxic salivary secretions by feeding arthropods.
Phytotoxemia is a physiological disorder in plants directly induced by the injection of toxic salivary secretions during arthropod feeding. Unlike viral or bacterial diseases, phytotoxemia is caused by chemical toxins rather than biological pathogens. These toxins can disrupt various cellular processes, leading to localized or systemic symptoms that resemble infectious diseases but are fundamentally different in origin and management.

95. (B) Phytotoxemia is caused by a chemical toxin and is non-infectious.
The fundamental difference between phytotoxemia and a viral infection lies in the nature of the causal agent. Phytotoxemia is caused by a chemical toxin present in the insect's saliva, making it a non-infectious disorder. In contrast, viral infections are caused by biological agents that can replicate and spread between plants. Consequently, phytotoxemia does not involve pathogen multiplication within the host.

96. (D) Empoasca species
"Hopperburn" is a classic phytotoxemic response characterized by characteristic V-shaped yellowing and necrosis along leaf margins. This condition is primarily caused by the feeding activity of leafhoppers in the genus Empoasca. These insects inject toxic saliva that blocks the vascular tissues and interferes with nutrient transport, leading to the rapid development of symptoms and significant damage to crops like potatoes.

97. (A) Secretion of salivary effectors interfering with growth regulators.
Systemic phytotoxemia, as seen in disorders like psyllid yellows, is driven by biochemical mechanisms where salivary effectors interfere with the plant's growth regulators. These injected toxins can move through the vascular system, affecting distant parts of the plant. By disrupting the normal hormonal balance, the saliva induces widespread physiological changes, such as stunting and yellowing, even in distant tissues.

98. (A) I - II - III - IV
The induction of a localized phytotoxemic response follows a specific chronological sequence. It begins with the insect probing the plant tissue, followed by the secretion of salivary effectors into the site. These toxins disrupt the cellular metabolism of the host, leading to physiological changes. Finally, the affected area exhibits localized tissue necrosis, representing the culmination of the physiological reaction to feeding.

99. (A) Nymphs of Bemisia tabaci biotype B.
Silverleaf disorder in squash is a systemic phytotoxemia directly linked to the feeding activity of the nymphs of Bemisia tabaci biotype B. As the nymphs feed on the phloem, they inject toxins that cause the characteristic silvering of the leaves. This disorder is not caused by a virus but is a physiological reaction to specific chemical components in the saliva.

100. (D) Ampeloviruses known as Pineapple mealybug wilt-associated viruses.
Mealybug wilt of pineapple was historically attributed solely to phytotoxemia caused by mealybug saliva. However, recent research has shown that the disorder is more complex, often involving the presence of Ampeloviruses known as Pineapple mealybug wilt-associated viruses. These viruses, transmitted by mealybugs, interact with the insect's toxic secretions to produce the severe wilting symptoms observed in many infected plantations.

101. (B) Cessation of toxin supply allows recovery mechanisms to restore function.
Recovery from true phytotoxemia typically occurs once the feeding arthropods are removed because the supply of the causal toxin is eliminated. Without a continuous injection of toxic saliva,

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the plant's internal recovery mechanisms can gradually restore normal cellular functions and physiological processes. This distinguishes phytotoxemia from infectious diseases, where the pathogen continues to multiply and spread after vector removal.

102. (C) Spring temperature fluctuations driving alate formation.
In Northern India, spring temperature fluctuations are the most significant climatic factor dictating aphid population dynamics and migration peaks. As temperatures rise during the spring months, aphid colonies rapidly expand and initiate the formation of alate, or winged, morphs. These winged individuals then take flight to find new host plants, leading to widespread dispersal and transmission of various viruses.

103. (D) Novel biotypes capable of breaking host resistance.
Sudden outbreaks of vector-borne epidemics often correlate with the emergence of novel vector biotypes. These biotypes may possess enhanced fitness, broader host ranges, or the ability to overcome existing host plant resistance. Their increased efficiency in acquiring and transmitting pathogens can lead to rapid disease spread within stable agricultural systems, necessitating the constant monitoring and adaptation of management strategies.

104. (A) Prevailing monsoon wind currents
The long-distance migration patterns of leafhoppers, which are crucial for the spread of diseases like Rice tungro, are heavily influenced by prevailing monsoon wind currents. These winds can carry viruliferous insects over hundreds of kilometers, introducing pathogens into new regions and initiating seasonal epidemics. Understanding these wind patterns is essential for predicting disease outbreaks and implementing timely regional control measures.

105. (A) I, II and IV
Weed reservoirs play a critical role in the epidemiology of vector-borne diseases by serving as overwintering or oversummering hosts for both pathogens and their vectors. They act as essential bridges between primary cropping seasons, maintaining the inoculum in the environment. By providing a stable habitat when the main crop is absent, these weeds ensure the continuous survival and eventual spread.

106. (B) An alternate host that maintains the viral inoculum.
In the epidemiology of Papaya ringspot virus (PRSV), cucurbitaceous weeds function as vital alternate hosts that maintain the viral inoculum during the off-season. These weeds harbor the virus and provide a source from which aphid vectors can acquire it. When new papaya plantations are established, the aphids move from the infected weeds to the crop, initiating a new disease epidemic.

107. (A) Sesame phyllody
The oversummering of the leafhopper vector Orosius albicinctus on weed hosts is a critical factor in the epidemiology of Sesame phyllody in India. This disease, caused by a phytoplasma, is maintained in wild vegetation during the hot summer months. When the sesame crop is sown, the viruliferous leafhoppers migrate from the weeds to the seedlings, leading to high disease incidence.

108. (C) Implementing a crop-free period and regional weed eradication.
The most effective strategy to break the epidemiological cycle sustained by weed reservoirs is the implementation of a regional crop-free period combined with systematic weed eradication. By removing the alternate hosts that bridge disease cycles, the available inoculum and vector populations are significantly reduced. This coordinated approach disrupts continuous transmission, protecting subsequent crops from early and severe seasonal infections.

109. (D) Short-distance dispersal of aphids from infected mats.
The spatial spread of Banana bunchy top virus (BBTV) within a plantation is primarily governed by the short-distance dispersal of aphid vectors from infected plant mats. These aphids move between closely spaced banana plants, leading to a patchy or aggregated distribution of the disease. While long-distance spread occurs through infected suckers, the localized epidemic is driven by these vector movements.

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These specialized hairs can trap small insects like whiteflies and thrips using sticky exudates or toxic compounds. By hindering movement and feeding, these trichomes significantly reduce the ability of vectors to colonize the plant and transmit viruses, offering biological protection.

128. (D) Reduced vector size and lowered reproductive rates.
Antibiosis in resistant host plants leads to direct negative outcomes for the vector population. When insects feed on these plants, they may experience reduced body size, slower development, and significantly lowered reproductive rates. These biological constraints result in a slower population growth rate in the field, which can effectively reduce the speed and extent of vector-borne disease epidemics over time.

129. (A) Naturally occurring insecticidal proteins like Bt toxins.
Transgenic resistance against specific viral vectors often utilizes genes derived from naturally occurring insecticidal proteins, such as those from Bacillus thuringiensis (Bt). By engineering the host plant to express these toxins, the plant can directly kill or deter feeding vectors. This targeted approach reduces the reliance on external chemical sprays and provides consistent protection throughout the growing season, particularly for young plants.

130. (C) mRNA transcripts of essential genes causing gene silencing.
RNA interference (RNAi) is a modern molecular approach to vector control that targets the mRNA transcripts of essential genes within the insect. By introducing double-stranded RNA specific to a target gene, the process induces gene silencing, preventing the synthesis of critical proteins. This disruption of vital biological functions can lead to reduced fitness, impaired transmission capacity, or direct vector mortality.

131. (A) Ingesting quantities of dsRNA or siRNA from the plant.
A critical requirement for the success of plant-mediated RNAi against an insect vector is the efficient ingestion of double-stranded RNA (dsRNA) or small interfering RNA (siRNA) from the host plant. The vector must consume enough of these molecules during its feeding process to trigger the internal RNAi machinery, leading to the silencing of its own target genes and biological consequences.

132. (D) Energy metabolism and ion transport in gut cells.
Targeting the vATPase gene in whiteflies through RNAi primarily disrupts essential physiological processes such as energy metabolism and ion transport within the gut cells. vATPases are critical for maintaining pH gradients and driving various transport mechanisms. Silencing this gene leads to severe cellular dysfunction and eventual mortality, making it a highly effective target for reducing vector populations and pathogen transmission.

133. (A) III - I - II - IV
Deploying plant-mediated RNAi follows a logical sequence. First, the host plant is engineered to express vector-specific double-stranded RNA. When the vector feeds, it ingests this dsRNA, which is then cleaved into siRNAs by the insect's Dicer enzyme. These siRNAs guide the RISC complex to degrade the target mRNA, resulting in the silencing of essential genes and causing insect mortality.

134. (C) Maintaining stable concentrations of dsRNA in phloem sap.
A significant challenge in utilizing RNAi against phloem-feeding vectors is maintaining stable and sufficient concentrations of dsRNA within the phloem sap. Since many vectors, such as aphids and whiteflies, are specialized phloem feeders, the delivery of the silencing signal must be targeted to these vascular tissues. Fluctuations in dsRNA levels or degradation within the plant can limit the overall effectiveness.

135. (D) Antixenosis
In classical host plant resistance terminology, the term "non-preference" is synonymous with antixenosis. This mechanism describes plant traits that affect the behavior of an insect vector, making the plant less attractive for landing, colonization, or sustained feeding. Antixenotic resistance can be based on various physical or chemical cues that deter the insect from selecting the plant as a host.

136. (A) Tolerant plants serve as hidden reservoirs for susceptible crops.
Tolerance is often considered less desirable than antibiosis or antixenosis because tolerant plants

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a high rate of secondary spread, as it reduces the available pathogen source.

119. (A) P-3, Q-1, R-4, S-2
Vector management strategies employ various mechanisms to reduce disease incidence. Systemic insecticides translocate within the plant to kill feeding vectors, while insect growth regulators disrupt the development of immatures. Reflective mulches provide a visual deterrent to prevent vector landing. Entomopathogenic fungi act through cuticular penetration, offering a biological approach to directly reducing vector populations within the agricultural environment.

120. (A) Systemic insecticides as seed treatments to kill vectors.
For managing persistently transmitted viruses like Cotton leaf curl virus, systemic insecticides used as seed treatments are highly logical. Since these viruses require long feeding durations for acquisition and inoculation, systemic chemicals present in the plant sap can kill the vectors before they successfully transmit the pathogen. This provides early-season protection during the crop's most vulnerable growth stages.

121. (B) Transmission during brief probes before ingesting lethal doses.
The primary limitation of systemic insecticides in preventing the transmission of non-persistent viruses is the speed of inoculation. Because these viruses are delivered during brief, superficial probes that last only a few seconds, vectors can successfully infect a plant before they ingest a lethal dose of the insecticide. Consequently, while these chemicals reduce vector populations, they often fail to stop initial spread.

122. (B) The development of nymphs into mature, reproductive adults.
Insect growth regulators (IGRs) are particularly effective for managing whitefly populations because they primarily target the development of nymphs into mature, reproductive adults. By interfering with hormonal pathways or chitin synthesis, IGRs prevent the successful molting and maturation of the immature stages. This disrupts the life cycle and gradually reduces overall population density, thereby lowering the disease pressure in the field.

123. (A) Adhesion of conidia to the cuticle and internal colonization.
The entomopathogenic fungus Beauveria bassiana controls vector populations through a unique infection process. It begins with the adhesion of fungal conidia to the insect's cuticle, followed by the germination of the spores and penetration of the exoskeleton. Once inside, the fungus colonizes the vector's internal tissues and produces toxins, eventually leading to the death of the insect host.

124. (C) Killing vectors that engage in sustained feeding activity.
Seed treatments with systemic insecticides alter the transmission rates of vector-borne pathogens by killing insects that engage in sustained feeding activity. As the seedling grows, the insecticide is translocated throughout the plant tissues. Vectors that feed on the phloem or xylem of these treated plants are exposed to the chemical and die, significantly reducing the primary spread of pathogens.

125. (D) Development of target-site resistance or metabolic detoxification.
The overuse of specific systemic insecticides for vector control can lead to the unintended development of resistance within the insect population. This often occurs through target-site mutations or enhanced metabolic detoxification mechanisms, rendering the chemicals ineffective. Such resistance necessitates higher application rates or alternative compounds, complicating pest management and potentially leading to more frequent and severe disease outbreaks in agricultural systems.

126. (A) I and II
Host plant resistance to vectors is categorized into three main mechanisms. Antixenosis, or non-preference, affects vector behavior by reducing landing and feeding on the plant. Antibiosis negatively impacts the vector's biology, such as its survival, growth, or reproductive capacity. In contrast, tolerance allows the plant to yield well despite the presence of the vector or pathogen, without reducing the population.

127. (B) Physical impediments and sticky exudates that trap small vectors.
Glandular trichomes on the surface of some wild tomato species contribute to vector resistance by providing physical and chemical impediments.

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110. (C) High humidity and moderate temperatures post-monsoon.
In North India, the temporal dynamics of Cotton leaf curl disease are heavily influenced by the population explosion of whiteflies following the monsoon. The combination of high humidity and moderate temperatures during the post-monsoon period creates ideal conditions for vector reproduction. This leads to a surge in the number of viruliferous whiteflies, resulting in the rapid and widespread spread of the virus.

111. (B) Transmission during brief probes before insecticides can kill.
Controlling Papaya ringspot virus (PRSV) with standard contact insecticides is extremely difficult because the virus is transmitted non-persistently during brief, superficial probes. Aphid vectors can acquire and inoculate the virus within seconds, often before they can be killed by the insecticide residue on the leaf surface. This rapid transmission mechanism makes traditional chemical control strategies largely ineffective for disease prevention.

112. (A) Both A and R are true and R is the correct explanation of A.
Adjusting sowing dates is a powerful cultural management strategy for mitigating vector-borne diseases. By altering the timing of crop establishment, farmers can disrupt the synchrony between the highly vulnerable seedling stage and the peak migration period of viruliferous vectors. This temporal escape ensures the plants are older and more resistant by the time vector populations reach their maximum seasonal levels.

113. (A) Reflecting ultraviolet light to disorient incoming vectors.
Reflective mulches, such as silver or aluminum-coated plastics, protect young plants from non-persistent viruses by reflecting ultraviolet light. This reflected radiation disorients incoming vectors, such as aphids and whiteflies, interfering with their ability to locate and land on the host plants. By deterring the initial colonization, these mulches significantly reduce the incidence of early-season viral infections in agricultural fields.

114. (C) Probing vectors lose the retained virus on their stylets.
Barrier crops function as a cultural management tool against non-persistently transmitted viruses by acting as a biological filter. When migrating aphids land on the non-host barrier plants and initiate brief probes to assess suitability, they lose the virus particles previously retained on their stylets. This cleansing effect ensures that when the vectors move to the main crop, they are non-viruliferous.

115. (A) A non-host for the specific virus being managed.
To be effective, a barrier crop must essentially be a non-host for the specific virus being managed. This ensures that even if vectors probe the barrier plants and transmit any virions they are carrying, the virus cannot replicate or establish an infection within the barrier. This property is crucial for the cleansing of vector mouthparts before they reach the crop.

116. (D) The maximum body width of the target vector species.
The effectiveness of insect-proof exclusion netting in greenhouses relies on selecting a mesh size tailored to the maximum body width of the target vector species. To prevent entry, the openings must be small enough to physically block insects like whiteflies, thrips, or aphids. Proper sizing is essential to provide a reliable physical barrier while still allowing for adequate air ventilation.

117. (B) Reduction in air circulation leading to elevated internal humidity.
A significant disadvantage of using fine physical exclusion netting in hot climates is the reduction in air circulation. The dense mesh can impede ventilation, leading to elevated internal temperatures and humidity levels within the greenhouse. These conditions can stress the plants and create a favorable environment for other issues, such as fungal diseases, necessitating careful management of the greenhouse microclimate.

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118. (C) Removing infected plants to eliminate internal inoculum.
Roguing is a cultural control practice that involves the systematic identification and removal of infected plants from a field. The primary goal is to eliminate internal sources of inoculum, preventing the further spread of the pathogen by resident vectors. This technique is especially important for managing diseases with

can serve as hidden reservoirs for pathogens. While these plants remain healthy and productive, they continue to harbor the virus or bacterium. Vectors can still acquire the pathogen from these plants and spread it to neighboring, susceptible crops, maintaining the epidemic within the agricultural landscape.

137. (B) It probes briefly and then abandons the plant without settling.
When a vector encounters a plant with strong antixenotic resistance, it typically exhibits a characteristic behavioral response. Instead of settling for sustained feeding, the insect may initiate a few brief probes to assess the plant and then quickly abandon it. This lack of colonization significantly reduces the opportunity for the vector to either acquire or transmit pathogens to that host.

138. (B) Integrated Pest Management (IPM)
The integration of modern technologies, such as transgenic crops expressing vector-targeting RNAi, with traditional cultural methods is a prime example of Integrated Pest Management (IPM). This holistic approach combines multiple tactics to manage vector populations and disease spread while minimizing environmental impact. By utilizing diverse strategies, IPM ensures more sustainable and resilient control of economically important vector-borne diseases.

139. (A) A vector exhibits both non-persistent and persistent traits.
Bimodal transmission refers to a specialized scenario where a vector can transmit a pathogen using more than one mechanism, typically exhibiting traits of both non-persistent and persistent transmission. This can occur with certain viruses that are carried on the stylets but also circulate or replicate internally. Such complexity in the vector-pathogen relationship can significantly influence the spread and epidemic speed.

140. (D) III
Persistent-propagative viruses are characterized by a mandatory internal multiplication phase, which necessitates a significant latent period of several days or weeks before the vector becomes infective. Therefore, the assertion that these viruses possess a very short latent period of just a few hours is incorrect. This long duration is a hallmark of their biological cycle, distinguishing them from non-persistent pathogens.

141. (D) Midgut barriers may be more permeable to viral transit.
Early-instar nymphs are often better acquirers of circulative viruses than adult vectors because their internal tissue barriers, such as the midgut epithelium, may be more permeable. This increased permeability allows for a more efficient transit of virions from the gut into the hemolymph. Consequently, a higher proportion of nymphs may become viruliferous, making them critical drivers of disease spread.

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142. (C) Chaperonins like GroEL protect luteoviruses in the hemolymph.
In aphids, endosymbionts like Buchnera aphidicola play a vital role in the transmission of Luteoviruses. These bacteria produce specialized chaperonin proteins, specifically GroEL, which are secreted into the aphid's hemolymph. The GroEL proteins bind to and protect the virions from being degraded by the insect's immune system, ensuring that they remain viable as they circulate toward the salivary glands for inoculation.

143. (B) Electrical Penetration Graph (EPG)
The Electrical Penetration Graph (EPG) is a sophisticated technique used to track the real-time probing and feeding behavior of piercing-sucking insects like aphids and leafhoppers. By incorporating the insect and plant into an electrical circuit, researchers can monitor specific voltage changes that correlate with different activities, such as stylet penetration, salivation, and sap ingestion, providing precise data on pathogen transmission.

144. (D) Inoculation moment for persistent-circulative viruses.
In EPG waveforms, the phloem salivation signal typically correlates with the exact moment of inoculation for persistent-circulative viruses. During this phase, the vector injects saliva into the sieve elements to prevent phloem sealing. If the vector is viruliferous, this salivation period serves as the primary window for the successful delivery of the pathogen into the host vascular system.

145. (A) Efficiency decreases as virus is washed off the stylet.
For non-persistent viruses, the transmission efficiency dramatically decreases if the aphid vector is forced to feed continuously for several hours on an infected plant. Since these viruses are carried on the external surfaces of the stylets, the constant flow of saliva and sap during sustained feeding acts to wash off or dilute the virions. Efficiency is highest during brief probes.

146. (C) DAG (Asp-Ala-Gly)
A classic characteristic of helper-dependent non-persistent transmission, such as that seen in Potyviruses, is the presence of a specific DAG (Asp-Ala-Gly) amino acid motif on the viral coat protein. This motif is essential for the interaction between the virion and the helper component protein. Mutations in this sequence can completely abolish the vector's ability to acquire and transmit the virus.

147. (C) A is true but R is false.
Mealybugs are indeed efficient vectors of certain closteroviruses, including those associated with grapevine leafroll. However, the reason provided is false, as adult female mealybugs are generally sedentary and lack wings. Their spread within a vineyard is primarily achieved through the movement of highly mobile first-instar nymphs, known as crawlers, or through the transport of infested plant material between sites.

148. (D) Patchy, aggregated distribution of nematode populations.
The spatial distribution of soil-borne viral diseases transmitted by nematodes is heavily dictated by the movement and population patterns of the vectors. Nematodes move very slowly through the soil, leading to a characteristically patchy or aggregated distribution of the disease within a field. These disease spots typically expand slowly over time, reflecting the localized nature of the nematode vector population.

149. (B) Xiphinema
The nematode genus Xiphinema, commonly known as dagger nematodes, is classically associated with the transmission of Nepoviruses, such as Tomato ringspot virus and Grapevine fanleaf virus. These nematodes possess a long, specialized feeding stylet used to penetrate root cells. The viruses are retained within the cuticular lining of the nematode's esophagus, allowing for persistent but non-circulative transmission between host plants.

150. (C) Lettuce big-vein virus
Olpidium brassicae is a soil-borne zoosporic fungus that acts as an important vector for several plant viruses, including Lettuce big-vein virus. The virus particles can adhere to the surface of the fungal zoospores or be carried internally. When the zoospores swim through soil water and infect the roots of a healthy plant, they simultaneously deliver the viral inoculum for infection.

151. (D) A vector that carries the pathogen and can transmit it.
A viruliferous vector is defined as an individual insect or arthropod that currently carries a pathogen and has the capacity to transmit it to a healthy host. This state is reached after the vector has successfully completed the necessary acquisition and, in the case of persistent pathogens, any required latent period. Being viruliferous is a prerequisite for subsequent disease spread.

152. (A) Sub-lethal doses agitate vectors, causing numerous short probes.
In agricultural settings, an application of a contact insecticide can inadvertently increase the spread of non-persistent viruses if the dose is sub-lethal. The chemical irritation can agitate the aphid vectors, causing them to move frequently and perform numerous short, superficial probes on multiple plants. This behavioral change can lead to a higher rate of virus inoculation across the entire field.

153. (B) Oils interfere with virion retention on stylets or probing.
Oil sprays are used to reduce the transmission of non-persistent viruses by interfering with the mechanical relationship between the virus and the vector's mouthparts. The oil film on the leaf surface can disrupt the ability of virions to adhere to or be released from the aphid's stylets during probing. This physical interference provides a protective barrier that lowers disease incidence.

154. (A) P-2, Q-3, R-1, S-4
Different virus families utilize specific vector groups and transmission mechanisms. Tospoviruses are transmitted by thrips in a persistent-propagative manner, while Begomoviruses rely on whiteflies

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for persistent-circulative spread. Potyviruses are classically non-persistent and often helper-dependent, whereas Cucumoviruses like CMV are also non-persistent but typically do not require specialized helper proteins for their rapid transmission by various common aphid species.

155. (A) Secretion of a solid salivary sheath reaching the vascular tissue.
The absolute prerequisite for the initial acquisition of a phloem-limited, persistently transmitted virus is the successful secretion of a solid salivary sheath that reaches the plant's vascular tissue. This specialized structure protects the stylets and facilitates the precise penetration into the sieve elements. Without this focused feeding behavior, the vector cannot ingest a sufficient quantity of the pathogen to transmit.

156. (C) Support endosymbionts that protect the virions in the hemolymph.
The vector competence of a specific Bemisia tabaci biotype is largely determined by its ability to support essential endosymbionts. These bacteria produce chaperone proteins, such as GroEL, which play a critical role in protecting begomoviruses from degradation within the whitefly's hemolymph. The efficiency of this internal protection mechanism directly influences the vector's capacity to successfully transport and transmit the virus.

157. (D) Immunofluorescence labeling coupled with Confocal Microscopy.
Modern molecular techniques, such as immunofluorescence labeling coupled with confocal microscopy, are increasingly used to identify viral retention sites within vector anatomy. By using fluorescently tagged antibodies that bind to viral proteins, researchers can visualize the precise localization of virions in tissues like the gut, hemolymph, or salivary glands. This high-resolution imaging provides critical insights into the internal barriers.

158. (C) Ensuring environmental stability and efficient uptake of dsRNA.
For the field application of RNAi-based vector control, the primary challenge is ensuring the environmental stability and efficient uptake of the double-stranded RNA (dsRNA). dsRNA molecules are susceptible to degradation by UV light and various environmental enzymes. Achieving a consistent and effective delivery to the target insects requires innovative formulation strategies that protect the molecules and facilitate their consumption.

159. (B) I, III and IV
Epidemiology involves studying the complex interplay between pathogens, vectors, hosts, and the environment. Effective disease management often relies on cultural and physical strategies. For instance, adjusting sowing dates disrupts vector-host synchrony, while exclusion netting physically blocks vector access to the crop. Additionally, managing weed reservoirs is crucial, as they often bridge disease cycles by harboring both the inoculum and vectors.

160. (D) To act as a sink that cleanses probing vectors of non-persistent viruses.
The primary objective of using barrier crops in integrated management is to act as a biological sink for non-persistent viruses. As migrating vectors land on and probe the non-host barrier plants, they lose the viral particles previously acquired from infected sources. This cleansing process significantly reduces the number of viruliferous vectors that eventually reach and infect the main host crop.

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NODIA

CHAPTER 15
Honey Bees and Bee-Keeping

2023

1. Which of the following accurately represents the taxonomic classification of honey bees within the order Hymenoptera?
(A) Suborder Symphyta, Superfamily Apoidea
(B) Suborder Apocrita, Superfamily Apoidea
(C) Suborder Apocrita, Superfamily Vespoidea
(D) Suborder Symphyta, Superfamily Chrysidoidea

2023

2. The genus Apis belongs to which specific subfamily within the family Apidae?
(A) Xylocopinae
(B) Nomadinae
(C) Bombinae
(D) Apinae

2014

3. Which of the following statements is INCORRECT regarding the phylogenetic relationships of honey bees?
(A) Stingless bees (Meliponini) are structurally entirely unrelated to the Apini tribe.
(B) They share a common ancestry with crabronid wasps.
(C) Orchid bees (Euglossini) and bumble bees (Bombini) are closely related to honey bees.
(D) Corbiculate bees represent a monophyletic group within the Apinae.

2022

4. What is the distinguishing morphological feature that separates the superfamily Apoidea from other hymenopteran groups?
(A) Presence of a fully developed ovipositor in all castes, including workers
(B) Two pairs of membranous wings with identical venation patterns across both
(C) Chewing-lapping mouthparts and specialized plumose body hairs
(D) Complete absence of a distinct petiole or narrow waist structure

2001

5. Consider the following statements regarding the taxonomic and structural traits of honey bees:
I. Apis species are characterized by the presence of a corbicula on the hind tibia of worker bees.
II. The suborder Apocrita is distinguished by the presence of a "wasp waist" or petiole.
III. Honey bees belong to the tribe Meliponini due to their advanced eusocial behavior.
Which of the above statement(s) is/are correct?
(A) I and III
(B) II only
(C) I and II
(D) II and III

2018

6. Which morphological structure forms the functionally integrated lapping tongue of the honey bee?
(A) Mandibles, labrum, and maxillary palps
(B) Epipharynx, mentum, and cardo
(C) Flabellum, submentum, and clypeus
(D) Glossa, galeae, and labial palps

2016

7. What is the primary function of the hamuli located on the wings of a honey bee?
(A) Enhancing high-frequency sound production during the waggle dance
(B) Coupling forewings and hindwings for synchronized flight
(C) Dispersing territorial pheromones during the initial mating flight
(D) Detecting subtle changes in localized barometric air pressure

2016

8. The antennae of a worker honey bee are classified as geniculate and comprise which distinct sequence of segments from base to tip?
(A) Pedicel, scape, flagellum
(B) Flagellum, pedicel, scape
(C) Scape, pedicel, flagellum
(D) Scape, flagellum, pedicel

2015

9. Identify the INCORRECT pair regarding honey bee leg modifications and their functions:
(A) Foreleg - Antenna cleaner (strigilis)
(B) Middle leg - Pollen spur for dislodging pollen

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(C) Hind leg - Corbicula for pollen storage
(D) Foreleg - Rastellum for compacting propolis

2019

10. The sting apparatus of a worker honey bee is a modified structure evolutionarily derived from which organ?
(A) Ovipositor
(B) Anal cerci
(C) Epiproctum
(D) Paraprocts

2023

11. Which structure prevents the honey bee worker from extracting its sting from the elastic skin of mammals?
(A) The structural bulb of the sting shaft
(B) Retrorse barbs on the paired lancets
(C) The smooth surface of the central stylet
(D) The venom sac's internal muscular attachment

2013

12. The following question consists of two statements: Assertion (A) and Reason (R). Select the correct answer using the codes given below:
Assertion (A): Worker honey bees typically die after stinging a vertebrate.
Reason (R): The barbed lancets of the sting apparatus anchor into the tissue, causing fatal abdominal rupture when the bee attempts to fly away.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019

13. Which exocrine gland is responsible for secreting a substance that assists in orienting foraging bees to the hive entrance?
(A) Nasonov gland
(B) Hypopharyngeal gland
(C) Arnhart gland
(D) Dufour's gland

2003

14. What is the primary physiological function of the hypopharyngeal glands in nurse bees?
(A) Secretion of beeswax for comb construction
(B) Production of alarm pheromones
(C) Biosynthesis of major components of royal jelly
(D) Secretion of invertase for nectar ripening exclusively

2008

15. In worker honey bees, the wax glands are morphologically situated on which specific body segments?
(A) Dorsal tergites 3 to 6
(B) Ventral sternites 2 to 5
(C) Dorsal tergites 4 to 7
(D) Ventral sternites 4 to 7

2015

16. Which of the following correctly describes a function of the mandibular glands in queen honey bees?
(A) Production of 10-HDA for specific larval feeding by nurse workers
(B) Secretion of foot-print pheromones to mark the honeycomb cell walls
(C) Production of 9-ODA to attract drones and inhibit worker ovaries
(D) Secretion of 2-heptanone to trigger an aggressive defensive response

2005

17. The Arnhart glands, also known as footprint glands, are strategically located on which part of the honey bee's body?
(A) The muscular base of the sting apparatus
(B) The arolium of the tarsus on each leg
(C) The specialized distal end of the antennae
(D) The inner surface of the chitinous mandibles

2023

18. Which statement about the glandular physiology of honey bees is most accurate?
(A) Drones possess highly developed hypopharyngeal glands used solely for self-feeding
(B) Wax glands remain highly active throughout the entire biological lifespan of a worker
(C) Salivary glands are solely located in the thorax and produce only lipid-based secretions
(D) Dufour's gland secretion coats eggs for protection and royal signaling

2005

19. Match the following glands with their corresponding secretions:
List I: (Gland)
P. Nasonov Gland
Q. Mandibular Gland (Worker)
R. Sting Gland (Koschevnikov)
S. Hypopharyngeal Gland
List II: (Secretion)

NODIA

Which of the following plants is well-documented as toxic to honey bees?
(A) Rhododendron spp.
(B) Moringa oleifera
(C) Pongamia pinnata
(D) Helianthus annua

2017

94. What are the standard dimensions of the external frame (length x depth) of a traditional Langstroth brood frame?
(A) 286 mm x 175 mm
(B) 300 mm x 150 mm
(C) 448 mm x 232 mm
(D) 482 mm x 232 mm

2005

95. The Newton hive, widely used in southern India, is specifically designed and dimensioned for hiving which species of honey bee?
(A) Apis mellifera
(B) Apis dorsata
(C) Apis florea
(D) Apis cerana

2010

96. Consider the following statements regarding standard movable-frame hives as per BIS specifications:
I. The Langstroth hive requires a standard bee space of exactly 15 mm.
II. The bottom board provides the base and incorporates the hive entrance.
III. The queen excluder is placed directly under the bottom board to prevent absconding.
IV. The super chamber is placed above the brood chamber specifically for surplus honey storage.
V. The inner cover maintains hive temperature and provides ventilation.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) II, III and V
(C) II, IV and V
(D) I, IV and V

2014

97. According to Indian Standards Institution (ISI) specifications, what is the primary difference between Type A and Type B hives for Apis cerana?
(A) Type A is for 10 frames, while Type B is only for 8 frames
(B) Type A is Newton (8 frames), Type B is Jeolikote (10 frames)
(C) Type A uses a sloping roof, while Type B uses a flat roof
(D) Type A is for high altitudes, while Type B is for the plains

2024

98. What is the primary function of the alighting board in a standard movable-frame hive?
(A) To prevent rainwater from seeping into the super chamber
(B) To act as a biological barrier against predatory wasps
(C) To separate the brood nest from the honey storage area
(D) Landing platform for returning foragers at the entrance

2017

99. The central hole typically found in the inner cover of a Langstroth hive serves which critical functions?
(A) Inserting bee escapes and aiding feeding or ventilation
(B) Exclusively for the queen to escape during swarming
(C) A viewing port that cannot be crossed by the worker bees
(D) Direct extraction of honey without opening the hive box

2025

100. Which type of wood is generally considered most suitable and durable for constructing standard bee hives in India, provided it is properly seasoned?
(A) Lightweight Balsa wood (Ochroma pyramidale)
(B) Unprocessed and freshly harvested green bamboo
(C) Teak (Tectona grandis) or Kail (Pinus wallichiana)
(D) Freshly cut Mango wood (Mangifera indica)

2022

101. The design principle of the queen excluder relies entirely upon:
(A) Physical difference in thorax size between queen and workers
(B) The aversion of the queen to zinc and plastic materials
(C) Specialized chemical repellents coated on the excluder
(D) Inability of large adult drones to fly strictly vertically

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(D) 2 days for queens, 3 days for workers, 4 days for drones

2021

28. Which is the total developmental period (egg to adult emergence) for an Apis mellifera worker bee?
(A) 16 days
(B) 21 days
(C) 24 days
(D) 28 days

2022

29. What physiological process initiates the transition from the larval stage to the prepupal stage in honey bees?
(A) Defecation and spinning of a silken cocoon by the larva
(B) High-volume consumption of bee bread by the developing larva
(C) Secretion of the final layer of protective beeswax over the cell
(D) Complete shedding of internal imaginal discs prior to pupation

2011

30. During the pupal stage, what major biological transformation occurs within the capped cell?
(A) Continuous ingestion of royal jelly to build critical lipid reserves
(B) Activation of arrhenotokous division in the developing somatic cells
(C) Histolysis of larval tissues and histogenesis of adult structures
(D) Frequent shedding of the exoskeleton to accommodate rapid growth

2018

31. Which of the following accurately describes the progressive pigmentation sequence of a honey bee pupa?
(A) Wings darken first, followed by the abdomen and lastly the eyes
(B) Eyes turn pink, purple, and brown before body pigmentation occurs
(C) The entire body darkens uniformly over a single 24-hour period
(D) The thorax darkens immediately following the initial cell capping

2003

32. Which of the following morphological features distinguishes the pupa of a drone from that of a worker?
(A) Presence of fully formed sting lancets and poison sac
(B) A distinctly elongated abdomen lacking any protective hair
(C) Large compound eyes that meet at the top of the head
(D) Presence of a fully developed corbicula on the hind tibia

2013

33. Select the correct sequential order of developmental stages in the life cycle of a drone bee:
(A) Egg → Pupa → Prepupa → Larva → Adult
(B) Egg → Larva → Prepupa → Pupa → Adult
(C) Egg → Prepupa → Larva → Pupa → Adult
(D) Larva → Egg → Prepupa → Pupa → Adult

NODIA

2001

34. Apis dorsata is commonly known as the rock bee. Which of the following represents its typical nesting habit?
(A) Multiple parallel combs located inside a dark, enclosed cavity
(B) A single small comb hidden within the foliage of dense bushes
(C) Irregularly shaped resin pots constructed in underground sites
(D) A single, large, open-air comb on high branches or cliffs

2003

35. Which indigenous Indian honey bee species is primarily known for cavity-nesting and is the traditional species used for hiving in India?
(A) Apis cerana
(B) Apis dorsata
(C) Apis florea
(D) Tetragonula iridipennis

2002

36. Identify the INCORRECT statement regarding the dwarf honey bee, Apis florea:
(A) It builds a single comb usually around a small branch of a bush
(B) It is highly migratory and prone to frequent, sudden absconding
(C) It is the most productive yielder among indigenous Apis species
(D) Its honey is traditionally valued for its medicinal properties

2010

37. Stingless bees belong to the tribe Meliponini. How do their nest structures differ fundamentally from those of the genus Apis?
(A) Rearing brood in hexagonal cells while storing honey in resin pots

1. Isopentyl acetate
2. Geraniol and citral
3. Invertase and royalactin
4. 2-heptanone

(A) P-2, Q-4, R-1, S-3
(B) P-1, Q-2, R-4, S-3
(C) P-2, Q-3, R-1, S-4
(D) P-3, Q-1, R-4, S-2

2021

20. The genetic phenomenon of arrhenotokous parthenogenesis in honey bees signifies which of the following mechanisms?
(A) Queens develop from unfertilized eggs while workers develop from fertilized eggs.
(B) Workers can lay diploid eggs in the absence of a queen.
(C) Drones develop from unfertilized, haploid eggs.
(D) Drones emerge from diploid eggs fertilized by multiple males.

2013

21. Epigenetic modification, specifically DNA methylation controlled by diet, is the primary driver for which crucial process in the honey bee colony?
(A) Female caste differentiation between queens and workers
(B) Biological transition from a nurse bee into a forager
(C) Temporal activation of specific drone congregation areas
(D) Initiation and onset of seasonal swarming behavior

2012

22. What causes the morphological and physiological suppression of ovaries in normal worker honey bees?
(A) Inadequate ambient temperature during the pupal stage
(B) A high-carbohydrate diet lacking pollen during early adulthood
(C) Accumulation of juvenile hormone beyond a critical threshold
(D) Continuous exposure to Queen Mandibular Pheromone (QMP)

2010

23. In the context of colony organization, polyandry by the queen serves which vital evolutionary advantage?
(A) It reduces the total number of individual eggs a queen must produce annually
(B) It significantly increases genetic diversity and colony disease resistance
(C) It ensures that all drones produced are genetically identical and uniform
(D) It accelerates the depletion of the queen's spermatheca to trigger supersedure

2025

24. Which condition invariably leads to the development of diploid drones in a honey bee colony?
(A) Lack of royal jelly feeding during the first three days of larval life
(B) Infestation of the developing egg by Varroa destructor
(C) Homozygosity at the complementary sex determiner (csd) locus
(D) Fertilization of an egg by a drone with a genetic mutation

2011

25. Identify the correct pair regarding the ploidy level and caste in Apis mellifera:
(A) Drone - Diploid (32 chromosomes)
(B) Worker - Haploid (16 chromosomes)
(C) Laying Worker - Diploid (16 chromosomes)
(D) Queen - Diploid (32 chromosomes)

2002

26. Consider the following statements regarding the developmental biology and caste system in honey bees:
I. The queen determines the sex of the offspring by controlling the release of sperm from the spermatheca.
II. All female larvae receive royal jelly exclusively throughout their entire developmental period.
III. Epigenetic control of the mTOR pathway is critical in female caste differentiation.
IV. Drones possess 16 chromosomes inherited solely from their mother.
Which of the above statement(s) is/are correct?
(A) I, III and IV
(B) II and III
(C) I, II and IV
(D) I and IV

2006

27. What is the standard duration of the egg stage for queens, workers, and drones of Apis mellifera?
(A) 2 days for all castes
(B) 3 days for all castes
(C) 3 days for queens, 4 days for workers, 5 days for drones

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2017

46. What specific behavioral phenomenon characterizes acclimatization of Apis mellifera in the varied agro-climatic zones of India?
(A) Permanent transition from cavity to open-air nesting
(B) Complete loss of the natural reproductive swarming instinct
(C) Foraging at specific times to avoid high summer heat
(D) Development of resistance to common synthetic pesticides

2018

47. Determine the correct sequential arrangement of events leading to reproductive swarming in a honey bee colony:
I. Rearing of drone brood
II. Construction of queen cups
III. Decreased queen oviposition and weight loss
IV. Engorgement of workers with honey
V. Departure of the prime swarm
Which of the following is the correct order?
(A) I → II → III → IV → V
(B) II → I → IV → III → V
(C) I → III → II → IV → V
(D) III → I → II → V → IV

2024

48. What is the fundamental difference between swarming and absconding in honey bees?
(A) Swarming is triggered by pests, while absconding is a reproduction process
(B) Swarming only occurs in winter, whereas absconding only occurs in spring
(C) Swarming divides colonies, while absconding involves the whole hive
(D) Absconding involves only drones and workers, leaving the queen behind

2006

49. Supersedure is a natural colony behavior defined as:
(A) The forceful eviction of all drones before the winter season
(B) Replacement of an old queen by a new one without division
(C) Rearing multiple queens simultaneously to initiate swarming
(D) The amalgamation of two weak colonies into one single unit

2019

50. During supersedure, where are the queen cells typically located on the brood comb?
(A) Exclusively along the lower margins of the comb
(B) Only outside the main brood nest in the honey super
(C) Attached directly to the bottom board
(D) Scattered on the face (surface) of the comb

2012

51. What acts as the primary physiological trigger initiating the construction of swarm cells in a congested colony?
(A) Low Queen Mandibular Pheromone (QMP) levels among workers
(B) A sudden, significant increase in external hive humidity
(C) An overabundance of empty comb space within the brood nest
(D) A severe shortage of stored pollen and nectar resources

2005

52. Virgin queens undertake mating flights typically within what timeframe after emergence?
(A) 1 to 2 days
(B) 5 to 10 days
(C) 15 to 20 days
(D) 25 to 30 days

2002

53. Where do mating flights of virgin queens specifically culminate for copulation?
(A) In aerial zones known as Drone Congregation Areas (DCAs)
(B) Inside the host colony's central brood nest area
(C) At the physical entrance of neighboring bee hives
(D) On flowers of major nectar-yielding agricultural crops

2013

54. The following question consists of two statements: Assertion (A) and Reason (R). Select the correct answer using the codes given below:
Assertion (A): The waggle dance communicates both the distance and direction of a food source.
Reason (R): Foragers perform the round dance when the food source is located at distances generally exceeding 100 meters.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

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2011

74. Propolis, a secondary bee product, is primarily synthesized by honey bees from which natural source?
(A) Resinous exudates collected from the buds and bark of trees
(B) Direct secretions from the bee's abdominal wax glands
(C) Regurgitated floral nectar mixed with pollen grains
(D) Degraded beeswax mixed with accumulated larval feces

2018

75. Consider the following statements regarding Royal Jelly:
I. It is secreted primarily by the hypopharyngeal and mandibular glands of nurse bees.
II. Its major lipid component is 10-hydroxy-2-decenoic acid (10-HDA).
III. It is fed exclusively to drone larvae after their third day of development.
IV. It exhibits significant antimicrobial and antioxidant properties.
Which of the above statement(s) is/are correct?
(A) I, II, and III
(B) II, III, and IV
(C) I, III, and IV
(D) I, II, and IV

2010

76. What is the approximate melting point range of pure beeswax, a standard parameter used to check its purity?
(A) 35°C - 40°C
(B) 45°C - 50°C
(C) 61°C - 65°C
(D) 80°C - 85°C

2025

77. Which of the following is an EXCEPTION to the primary therapeutic uses of apitoxin (bee venom)?
(A) Treatment of severe acute bacterial meningitis
(B) Management of rheumatoid arthritis pain
(C) Desensitization therapy for bee sting allergies
(D) Potential anti-inflammatory applications in alternative medicine

2017

78. Which powerful peptide constitutes about 50% of the dry weight of honey bee venom and acts as the primary pain-inducing and cell-lysing agent?
(A) Apamin
(B) Phospholipase A2
(C) Melittin
(D) Hyaluronidase

2018

79. What is the most common commercial method utilized for the extraction and purification of propolis from hive scrapings?
(A) Fractional distillation using clean boiling water
(B) Cold pressing using mechanical hydraulic presses
(C) Advanced sublimation performed under high vacuum
(D) Maceration and dissolution in high-proof ethanol

2024

80. The unique, naturally occurring fatty acid 10-HDA is strictly used as a marker for the authenticity and quality of which bee product?
(A) Pure Beeswax
(B) Crude Bee Venom
(C) Royal Jelly
(D) Crude Propolis

2016

81. The specialized mode of pollination where honey bees transfer pollen from the anther to the stigma of flowers is termed:
(A) Anemophily
(B) Entomophily
(C) Ornithophily
(D) Chiropterophily

2013

82. The following question consists of two statements: Assertion (A) and Reason (R). Select the correct answer using the codes given below:
Assertion (A): Honey bees are considered highly efficient and reliable crop pollinators compared to many other insects.
Reason (R): Honey bees exhibit "floral fidelity" or constancy, restricting their foraging flights to a single plant species at a time.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2013

83. Which horticultural crop is almost entirely (100%) dependent on honey bee cross-pollination for commercial fruit set and yield?
(A) Almond

NODIA

2025

64. What is the primary function of the compound 2-heptanone, secreted by the mandibular glands of worker bees?
(A) It attracts drones during the seasonal mating flight
(B) It acts as a floral attractant for young naive foragers
(C) Local anesthetic used to paralyze small intruders
(D) It prevents crystallization of honey within the comb

2016

65. The Brood Ester Pheromone (BEP) emitted by larvae serves to communicate which specific need to adult workers?
(A) The urgent need for additional hive ventilation
(B) The larval requirement for proteinaceous food
(C) The necessity to construct drone-sized brood cells
(D) The readiness of the larva to be capped by workers

2002

66. How do the release of sting pheromone affect the behavior of nearby guard bees?
(A) It induces a state of torpor to avoid detection by predators
(B) It stimulates foraging activity to compensate for worker loss
(C) It decreases sensitivity to fast movement and dark colors
(D) Lowering defensive thresholds and directing bees to targets

2012

67. According to AGMARK standards for apiary honey in India, what is the maximum permissible moisture content for Special Grade honey?
(A) 16%
(B) 20%
(C) 22%
(D) 25%

2014

68. Consider the following statements regarding the enzymatic composition and quality of honey:
I. Diastase activity decreases when honey is subjected to high heat.
II. Invertase is responsible for converting sucrose into glucose and fructose.
III. High Hydroxymethylfurfural (HMF) content indicates freshly harvested, unheated honey.
Which of the above statement(s) is/are INCORRECT?
(A) I only
(B) II only
(C) III only
(D) I and II

2016

69. Which of the following limits is strictly monitored by FSSAI as an indicator of adulteration, aging, or excessive heating in commercial honey?
(A) Hydroxymethylfurfural (HMF)
(B) Synthetic ascorbic acid
(C) Fermented gluconic acid
(D) Residual hydrogen peroxide

2002

70. What is the primary physical cause of granulation (crystallization) in pure honey?
(A) High levels of sucrose exceeding fifteen percent of total weight
(B) The presence of artificially added sugar syrups and fillers
(C) Exposure to direct intense sunlight during primary processing
(D) High glucose-to-water ratio and glucose precipitation

2003

71. The specific gravity of well-ripened honey at 27°C, as per standard commercial requirements, should not be less than:
(A) 1.15
(B) 1.35
(C) 1.65
(D) 1.85

2018

72. Which natural enzyme found in honey is primarily responsible for its inherent antibacterial properties through the slow release of hydrogen peroxide?
(A) Amylase
(B) Catalase
(C) Glucose oxidase
(D) Acid phosphatase

2021

73. What are the two major monosaccharides that constitute approximately 70-80% of the solid weight of honey?
(A) Sucrose and Maltose
(B) Galactose and Fructose
(C) Lactose and Glucose
(D) Fructose and Glucose

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(B) They build vertical, parallel wax combs for both brood and honey
(C) They construct nests from pure beeswax without adding plant resins
(D) They do not cap their brood cells at any stage during development

2001

38. Apis cerana is noted for displaying which distinct defensive behavior not commonly observed in Apis mellifera?
(A) Stinging intruders en masse resulting in rapid bee mortality
(B) Smearing plant resins near the entrance to trap predators
(C) Biting predators with their mandibles and entirely refusing to sting
(D) Shimmering behavior (coordinated body shaking) to deter wasps

2023

39. Which biological characteristic makes Apis cerana particularly resilient to the parasitic mite Varroa destructor in its natural habitat?
(A) The mite cannot penetrate the thick cuticle of Apis cerana workers.
(B) Varroa mites exclusively reproduce in the drone brood of Apis cerana.
(C) The developmental period of Apis cerana workers is too long for the mite to mature.
(D) Apis cerana completely lacks the chemical volatile compounds that attract Varroa.

2005

40. Consider the following statements regarding indigenous Indian bee species:
I. Apis dorsata is a highly docile species preferred for backyard beekeeping.
II. Tetragonula iridipennis lacks a functional host apparatus.
III. Apis cerana indica builds multiple parallel combs.
IV. Apis florea workers are significantly larger than Apis dorsata workers.
V. The honey yield per colony of Apis cerana generally exceeds that of standard Apis mellifera colonies.
Which of the above statement(s) is/are INCORRECT?
(A) II, III and IV
(B) I, III and V
(C) I, IV and V
(D) II, IV and V

2004

41. In which year was the European honey bee (Apis mellifera) successfully introduced and established in India by Dr. A.S. Atwal?
(A) 1951
(B) 1962
(C) 1975
(D) 1983

2005

42. Which specific subspecies of Apis mellifera was primarily imported and acclimated in India due to its prolific breeding and high honey yield?
(A) Apis mellifera ligustica
(B) Apis mellifera carnica
(C) Apis mellifera caucasia
(D) Apis mellifera scutellata

2007

43. What was the primary geographical location in India where Apis mellifera was first successfully established?
(A) Bangalore, the capital of Karnataka
(B) Nagrota Bagwan, Himachal Pradesh
(C) Pune, a city in western Maharashtra
(D) Pusa, located in the state of Bihar

2001

44. What was the main biological challenge faced during the initial attempts to introduce Apis mellifera to India?
(A) Severe cold rendering the bees unable to forage effectively
(B) Predatory wasps, native wax moths, and viral diseases
(C) Inter-specific mating with Apis cerana producing sterile hybrids
(D) Total refusal to forage on the diversity of native Indian flora

2023

45. When comparing Apis mellifera to Apis cerana, which trait makes A. mellifera more suitable for large-scale commercial beekeeping?
(A) A prolific queen and larger colony population size
(B) Higher tendency to abscond during the dearth periods
(C) Slower spring build-up causing lower food consumption
(D) Complete immunity to the American Foulbrood disease

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(B) Wheat
(C) Tomato
(D) Potato

2002

84. Which characteristic morphological feature of honey bees significantly enhances their efficiency in pollen transfer during cross-pollination?
(A) The smooth and hairless surface of the worker abdomen
(B) The presence of a long and sharp sting apparatus
(C) Highly branched, plumose hairs covering the body
(D) The streamlined shape of their closed chitinous mandibles

2006

85. Identify the INCORRECT pair linking a crop to its standard recommended colony density for optimal pollination (per hectare):
(A) Rice - 5 to 7 colonies/ha
(B) Apple - 3 to 4 colonies/ha
(C) Sunflower - 3 to 5 colonies/ha
(D) Alfalfa - 5 to 10 colonies/ha

2010

86. Honey bees facilitate cross-pollination in alfalfa (lucerne) by activating which specific floral mechanism?
(A) Buzz-type pollination
(B) False pseudocopulation
(C) External nectar robbing
(D) Tripping mechanism

2003

87. In an integrated orchard management system, the placement of honey bee colonies for apple pollination should ideally coincide with which blooming stage?
(A) Several weeks before any flower buds start to appear
(B) When 10% to 20% of the blossoms have opened
(C) At the exact biological moment of total petal fall
(D) During the subsequent fruit expansion growth phase

2016

88. The comprehensive term "bee pasturage" or "bee flora" specifically refers to:
(A) Land designated for placing hives during migration
(B) Grass and weeds growing immediately around hive stands
(C) Collective vegetation providing nectar and pollen
(D) Specific agricultural crops treated with safe pesticides

2001

89. Match the following major bee flora with their primary reward for honey bees:
List I: (Bee Flora)
P. Mustard (Brassica spp.)
Q. Rubber (Hevea brasiliensis)
R. Maize (Zea mays)
S. Eucalyptus (Eucalyptus spp.)
List II: (Primary Reward)
1. Only pollen
2. Major nectar, minimal pollen (extra-floral)
3. Both rich nectar and abundant pollen
4. Major nectar and good pollen
(A) P-1, Q-2, R-4, S-3
(B) P-3, Q-1, R-2, S-4
(C) P-4, Q-3, R-1, S-2
(D) P-3, Q-2, R-1, S-4

2010

90. What is the primary utility of preparing a "floral calendar" in commercial apiculture?
(A) To plan migration, feeding, and honey harvest schedules
(B) To determine the precise days when swarming will occur
(C) To identify the exact chemical composition of honey types
(D) To track the generational life cycles of the Varroa mite

2018

91. Which of the following is generally considered a minor or non-yielding source of nectar for honey bees in India?
(A) Litchi (Litchi chinensis)
(B) Wheat (Triticum aestivum)
(C) Ber (Ziziphus mauritiana)
(D) Jamun (Syzygium cumini)

2009

92. During the dearth period in many parts of India, which type of flora is crucial for colony survival even if it doesn't yield surplus honey?
(A) Major cultivated fruit tree orchards
(B) Wild herbs, weeds, and minor forest flora
(C) High-yielding oilseed commercial crops
(D) Large-scale industrial timber plantations

2012

93. While foraging, honey bees may sometimes collect nectar or pollen containing toxic alkaloids.

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2010

55. In the waggle dance, the duration of the straight waggle run directly correlates to which parameter of the food source?
(A) The overall sugar concentration of the foraging nectar
(B) The distance of the food source from the hive
(C) The specific floral scent of the blooming flower species
(D) The total volume of liquid nectar currently available

2024

56. How do honey bees encode the direction of a food source during a waggle dance performed in the dark on a vertical comb?
(A) The frequency of wing beats indicates the exact compass direction
(B) Dancer faces the compass direction during the circular phase
(C) Angle to gravity represents food angle relative to the sun
(D) Dancer points her antennae strictly toward the magnetic north

2019

57. The phenomenon of division of labor in worker honey bees is primarily based on:
(A) The morphological size of the worker bee upon emergence
(B) The genetic lineage of the drone that sired the worker bee
(C) The specific type of cell in which the worker bee was reared
(D) Temporal polyethism where duties change with worker age

2023

58. Foragers measure the distance to a food source by utilizing which physiological mechanism during flight?
(A) Processing optic flow of visual patterns across the retina
(B) Simply counting the total number of individual wingbeats
(C) Assessing energy expenditure through foraging consumption
(D) Monitoring subtle shifts in the earth's magnetic field

2012

59. What happens to the foraging force when a honey bee colony completely lacks stored pollen?
(A) All foragers switch to collecting only water exclusively
(B) More foragers collect pollen for larval protein demands
(C) Foraging ceases entirely to conserve the colony's energy
(D) The colony triggers immediate and total hive absconding

2015

60. Identify the correct pair matching the communicative dance to its discoverer:
(A) Round Dance - L.L. Langstroth
(B) Waggle Dance - Karl von Frisch
(C) Tremble Dance - Ronald Fisher
(D) Grooming Dance - Gregor Mendel

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2014

61. Match the following pheromones with their primary source and function:
List I: (Pheromone)
P. 9-ODA
Q. Isopentyl acetate (IPA)
R. Brood Ester Pheromone (BEP)
S. E-beta-ocimene
List II: (Source and Function)
1. Larvae; regulates nurse bee feeding and foraging
2. Queen mandibular gland; inhibits queen rearing
3. Sting apparatus; alerts and marks targets
4. Larvae; inhibits worker ovary development and regulates development
(A) P-1, Q-2, R-3, S-4
(B) P-3, Q-1, R-4, S-2
(C) P-2, Q-4, R-1, S-3
(D) P-2, Q-3, R-1, S-4

2007

62. Which chemical compound constitutes the primary active component of the honey bee alarm pheromone?
(A) 10-hydroxy-2-decenoic acid
(B) Methyl palmitate
(C) Isopentyl acetate
(D) Geraniol

2010

63. Which intra-colony pheromone is critical for creating a cohesive "retinue" of worker bees around the queen?
(A) The attractive Nasonov pheromone
(B) Mandibular gland 2-heptanone
(C) Volatile hexyl acetate ester
(D) Queen Mandibular Pheromone (QMP)

2016

102. In apiary management, what is the fundamental purpose of using a smoker during colony inspection?
(A) The heat directly paralyzes the bees' wing muscles
(B) Smoke rapidly decreases the ambient hive temperature
(C) The smoke causes guard bees to quickly abandon the hive
(D) Smoke masks alarm pheromones and induces bees to engorge

2003

103. Select the correct sequence of steps involved in the mechanical extraction of honey:
I. Uncapping the sealed honey cells
II. Removing frames filled with sealed honey from the super
III. Filtering and settling the extracted honey
IV. Centrifuging the frames in a honey extractor
Which of the following is the correct order?
(A) I → II → IV → III
(B) II → IV → I → III
(C) II → I → IV → III
(D) I → IV → II → III

2011

104. When using an uncapping knife to remove wax seals from honeycombs, the knife is typically heated. What is the primary reason for this?
(A) To pasteurize the honey instantaneously during use
(B) To kill any Varroa mites lurking beneath the cappings
(C) Slicing wax cappings without tearing the comb structure
(D) To permanently seal the edges of the cells after use

2012

105. What is the key operational difference between a tangential honey extractor and a radial honey extractor?
(A) Radial extractors crush the wax combs to extract the honey
(B) Tangential extractors utilize high-pressure vacuum systems
(C) Radial extractors can only hold two frames at any one time
(D) Tangentials require turning frames; radials extract both sides

2017

106. Which specific tool is inserted into the inner cover to allow worker bees to exit the honey super but prevents them from returning, facilitating a bee-free harvest?
(A) Porter bee escape
(B) Metallic drone trap
(C) Plastic queen excluder
(D) Wooden entrance reducer

2009

107. The discovery of the "bee space" concept revolutionized modern beekeeping. In which year did Rev. L.L. Langstroth patent the movable-frame hive based on this principle?
(A) 1789
(B) 1810
(C) 1851
(D) 1895

2002

108. The optimum bee space for Apis mellifera, which prevents them from building brace comb or sealing gaps with propolis, is approximately:
(A) 8 mm ($\frac{5}{16}$ inch)
(B) 3 mm ($\frac{1}{8}$ inch)
(C) 15 mm ($\frac{5}{8}$ inch)
(D) 25 mm (1 inch)

2002

109. What is the predictable biological consequence if the space between two hive frames is significantly larger than the standard bee space?
(A) Bees construct irregular burr and brace comb in the gap
(B) The bees will seal the gap entirely with sticky propolis
(C) The queen will lay multiple eggs in the unoccupied void
(D) The bees will abandon the hive due to internal drafts

2011

110. Determine the proper sequential arrangement for conducting a routine colony inspection:
I. Remove the inner cover gently
II. Puff smoke at the hive entrance
III. Remove and inspect frames starting from the periphery
IV. Lift the outer cover (roof)
Which of the following is the correct order?
(A) IV → I → II → III
(B) II → I → IV → III
(C) I → II → IV → III
(D) II → IV → I → III

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(A) AFB affects adult bees, while EFB affects only larvae
(B) EFB causes ropiness of dead larvae, which AFB does not
(C) AFB kills after capping; EFB kills before capping
(D) AFB turns larvae chalk-white, while EFB turns them black

2022

129. The "ropiness test" using a matchstick is a standard field diagnostic technique for confirming the presence of:
(A) The Sacbrood Virus
(B) American Foulbrood
(C) Fungal Chalkbrood
(D) Fungal Stonebrood

2007

130. A beekeeper observes dead prepupae inside capped cells that look like fluid-filled, gondola-shaped sacs with thickened, darkened heads. This symptom is uniquely characteristic of:
(A) American Foulbrood
(B) Deformed Wing Virus
(C) European Foulbrood
(D) Sacbrood Virus

2002

131. Consider the following statements regarding viral diseases of honey bees:
I. Deformed Wing Virus (DWV) is primarily transmitted by the Varroa mite.
II. Sacbrood virus mainly infects adult foragers, causing them to find their wings.
III. Black Queen Cell Virus (BQCV) is highly associated with Nosema infections.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2025

132. Which of the following is NOT a viral disease affecting honey bee colonies?
(A) Chronic Bee Paralysis Virus (CBPV)
(B) Thai Sacbrood Virus (TSBV)
(C) Septicemia
(D) Kashmir Bee Virus (KBV)

2011

133. European Foulbrood (EFB) outbreaks are often stress-related. Historically, which antibiotic has been permitted in some regions as a preventive/curative treatment for EFB?
(A) Oxytetracycline (Terramycin)
(B) Crystalline Sodium Penicillin
(C) Synthetic Pyrethroid Fluvalinate
(D) Microsporidian Drug Fumagillin

2005

134. Nosemosis is a widespread disease of adult honey bees. The microsporidian pathogen Nosema apis directly attacks and multiplies within which specific tissue of the bee?
(A) The circulating liquid hemolymph
(B) The thoracic skeletal flight muscles
(C) The worker hypopharyngeal glands
(D) Epithelial cells of the ventriculus

2017

135. Chalkbrood is an infectious fungal disease that turns bee larvae into hard, mummified white or black pellets. It is caused by:
(A) Aspergillus flavus
(B) Ascosphaera apis
(C) Malpighamoeba mellificae
(D) Paenibacillus alvei

NODIA

2002

136. Which fungal pathogen is responsible for Stonebrood disease in honey bees and also poses a minor respiratory hazard to humans handling infected combs?
(A) Fungal pathogen Ascosphaera apis
(B) Microsporidian Nosema ceranae
(C) Aspergillus fumigatus / A. flavus
(D) Entopathogen Beauveria bassiana

2005

137. A classic, observable field symptom of severe Nosemosis in a honey bee colony during late winter or early spring is:
(A) Workers displaying paralyzed legs on the alighting board
(B) Sunken and perforated wax cappings on the capped brood
(C) Presence of mummified larvae at the front hive entrance
(D) Excessive fecal spotting on the hive and top bars

2024

138. Consider the following statements regarding adult bee diseases:
I. Nosema ceranae is generally considered more virulent and widespread today than Nosema apis.
II. Acarapis woodi lives and reproduces in the prothoracic tracheae of adult bees.
III. Nosema spores are primarily transmitted

(B) Moving colonies to exploit sequential nectar flows
(C) Allowing bees to revert to their wild nesting habits
(D) Isolating the diseased colonies from the healthy ones

2005

120. When uniting two honey bee colonies, the most common and safest method involves placing a barrier between the two boxes to allow their odors to mix gradually. What is this barrier made of?
(A) A thick and solid wooden divider board
(B) A flexible sheet of transparent plastic
(C) A sheet of newspaper with small slits
(D) A standard perforated zinc queen excluder

2024

121. The Doolittle method is a globally recognized technique used in advanced apiculture for what specific purpose?
(A) Mechanical extraction of refined beeswax
(B) Eradication of Varroa mites using organic acids
(C) Trapping and harvesting of crude propolis
(D) Commercial queen rearing via larval grafting

2007

122. During routine inspection, a beekeeper finds multiple eggs laid haphazardly in single worker cells, and many eggs attached to the sides rather than the bottom of the cells. This is a definitive sign of:
(A) Laying workers due to prolonged queenlessness
(B) The presence of a highly prolific young queen
(C) A severe infestation of the Tropilaelaps mites
(D) The initiation of imminent swarming behavior

2004

123. For successful artificial queen rearing using the grafting technique, what is the optimal age of the worker larva transferred into the queen cup?
(A) Larvae that are 4 to 5 days old
(B) Larvae that are 3 to 4 days old
(C) 12 to 24 hours old (1st instar)
(D) Larvae at the late prepupal stage

2018

124. Match the following advanced apiculture tools/ concepts with their appropriate definitions:
List I: (Tool/Concept)
P. Grafting Needle
Q. Cell Protector
R. Mating Nuc
S. Breeder Queen
List II: (Definition)
1. Small colony used solely for virgin queens to mate and begin laying
2. Selectively bred mother whose larvae are used for grafting
3. Tool used to transfer delicate larvae from worker cells to queen cups
4. Wire or plastic cage shielding a mature queen cell from worker destruction
(A) P-2, Q-1, R-4, S-3
(B) P-4, Q-3, R-1, S-2
(C) P-1, Q-4, R-2, S-3
(D) P-3, Q-4, R-1, S-2

NODIA

2012

125. In a commercial two-stage queen rearing setup, what is the functional difference between the "starter" and "finisher" colonies?
(A) Starters accept grafts; finishers complete construction
(B) Starters provide the eggs; finishers provide the pollen
(C) Starters are in darkness; finishers are in direct light
(D) Starters rear drone cells; finishers rear queen cells

2018

126. Dividing a strong, populous colony into two or more smaller units (nucs) is a primary management strategy used to:
(A) Increase honey production per hive immediately
(B) Cure colonies infected with American Foulbrood
(C) Multiply colonies and prevent natural swarming
(D) Encourage the production of additional propolis

2004

127. American Foulbrood (AFB) is a highly destructive, devastating brood disease caused by which spore-forming bacterium?
(A) Melissococcus plutonius
(B) Ascosphaera apis
(C) Nosema ceranae
(D) Paenibacillus larvae

2023

128. What is a key diagnostic difference in the symptoms of American Foulbrood (AFB) compared to European Foulbrood (EFB)?

2005

111. When selecting a site for a commercial apiary, which of the following environmental features should generally be avoided?
(A) Abundant and diverse bee flora within a fixed two km radius
(B) Close proximity to a clean and fresh natural water source
(C) Natural windbreaks such as tall hedges or existing tree lines
(D) Deep, damp valleys prone to waterlogging and stagnant air

2025

112. To prevent drifting and minimize disease transmission among hives in an apiary, what is the recommended minimum spacing between individual colonies?
(A) 2 to 3 meters
(B) 0.5 meters
(C) 10 to 15 meters
(D) Stacked directly on top of each other

2025

113. What is the primary objective of providing stimulative sugar syrup feeding to honey bee colonies during the early spring season?
(A) To immediately harvest the syrup as surplus honey stores
(B) To stimulate queen laying and accelerate colony build-up
(C) To lower the internal ambient temperature of the hive
(D) To cure active infections of the European Foulbrood

2021

114. During severe summer heat, what physiological mechanism do honey bees employ to maintain the optimal brood nest temperature (approx. 34-35°C)?
(A) They cluster around the brood to generate metabolic heat
(B) They stop foraging entirely to reduce internal heat
(C) They consume excess pollen to lower their body temperatures
(D) Spreading water over combs and fanning for cooling

2018

115. Monsoon management of apiaries in India is particularly critical due to the risk of:
(A) Starvation, humidity, and outbreaks of fungal diseases
(B) Excessive nectar flow causing honey bound brood nests
(C) High swarming tendency due to favorable weather conditions
(D) Rapid development of laying workers and drone layers

2024

116. The practice of "wintering" or "packing" hives in temperate zones or high altitudes serves primarily to:
(A) Encourage the queen to continue laying at peak capacity through winter
(B) Trap pests like the wax moth outside the hive
(C) Conserve colony heat and reduce the consumption of winter honey stores
(D) Prevent the queens from taking premature mating flights

2003

117. The following question consists of two statements: Assertion (A) and Reason (R). Select the correct answer using the codes given below:
Assertion (A): Artificial sugar feeding is strictly necessary for weak colonies during the prolonged monsoon season in India.
Reason (R): Foraging is severely restricted by heavy rains, leading to a rapid depletion of stored food and risk of starvation.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019

118. Which of the following is a standard management technique to prevent unwanted reproductive swarming in a strong colony during the spring nectar flow?
(A) Feeding heavy concentrations of sugar syrup daily
(B) Removing the queen and leaving the colony queenless
(C) Sealing the entrance to prevent the swarm from exiting
(D) Reversing brood chambers and providing supers for space

2022

119. Migratory beekeeping is a specialized practice aimed at:
(A) Permanently relocating bees to escape pesticide applications

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through the exchange of royal jelly among nurse bees.

IV. Severe Nosema infection significantly reduces the lifespan of worker bees.

Which of the above statement(s) is/are INCORRECT?

(A) I only
(B) III only
(C) II and IV
(D) I and III

2006

139. Which active pharmaceutical ingredient (API) is specifically formulated and widely recognized for controlling Nosemosis in honey bees?

(A) Amitraz
(B) Fumagillin
(C) Coumaphos
(D) Tylosin tartrate

2006

140. The ectoparasitic mite Varroa destructor originally co-evolved as a relatively benign parasite on which natural host species before crossing over to Apis mellifera?

(A) Apis florea
(B) Apis cerana
(C) Apis dorsata
(D) Apis mellifera scutellata

2002

141. Tropilaelaps clareae is a fast-moving parasitic mite of honey bees. Unlike Varroa, Tropilaelaps is entirely dependent on which specific hive resource for its survival?

(A) Continuous availability of bee brood
(B) Abundant and diverse pollen stores
(C) Seasonal winter clustering behavior
(D) Specialized drone congregation areas

2012

142. Acarapis woodi causes Acarine disease. Where does this microscopic mite complete its entire life cycle?

(A) Externally, under the abdominal sternites of workers
(B) Inside the capped brood cells of the drone larvae
(C) Internally, within the prothoracic tracheal tubes
(D) Inside the queen's specialized internal spermatheca

2010

143. Which of the following is an integrated pest management (IPM) physical technique used to monitor and reduce Varroa mite populations in a hive?

(A) Feeding pollen substitutes laced with high levels of salt
(B) Placing a solid and non-removable wooden bottom board
(C) Painting the hive exterior surfaces bright white
(D) Using a screened bottom board with a sticky board

2013

144. Which organic acid is commonly utilized by commercial beekeepers as an effective fumigant to control Varroa and tracheal mites without leaving permanent synthetic residues in wax?

(A) Acetic acid
(B) Lactic acid
(C) Formic acid
(D) Butyric acid

2024

145. The following question consists of two statements: Assertion (A) and Reason (R). Select the correct answer using the codes given below:

Assertion (A): Tropilaelaps clareae cannot survive in a broodless honey bee colony for more than a few days.

Reason (R): The mouthparts of Tropilaelaps are unable to pierce the hard integument of adult bees to feed on hemolymph or fat bodies.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

NODIA

2018

146. A critical difference in the reproduction of Varroa destructor compared to Tropilaelaps clareae is that Varroa:

(A) Reproduces exclusively on the developing queen larvae
(B) Completes its life cycle entirely outside the hive box
(C) Lays its eggs directly into the stored nectar cells
(D) Feeds on adult bees in a phoretic phase between cycles

2025

147. What is the scientific name of the greater wax moth, the most destructive insect pest of stored honeycombs and weak colonies?

hypopharyngeal glands synthesize invertase and royalactin, which are vital for honey production and the development of the larvae within the hive.

20. (C) Drones develop from unfertilized, haploid eggs.
Arrhenotokous parthenogenesis is a reproductive mechanism where males develop from unfertilized eggs, resulting in haploid drones. These drones possess only one set of chromosomes inherited from the queen. Conversely, females, including both workers and queens, develop from fertilized eggs and are diploid. This haplo-diploid sex-determination system is a fundamental characteristic of the biology of honey bees and other Hymenoptera.

21. (A) Female caste differentiation between queens and workers
The differentiation of female honey bees into either workers or queens is driven by nutrition-induced epigenetic changes. Larvae fed exclusively on royal jelly experience specific DNA methylation patterns that activate queen-related genes. This dietary control over gene expression demonstrates how environmental factors can profoundly influence the physiological development and social roles of individuals within a genetically identical female brood.

22. (D) Continuous exposure to Queen Mandibular Pheromone (QMP)
In a healthy colony, worker bees remain reproductively sterile due to the influence of the Queen Mandibular Pheromone (QMP). This chemical signal, distributed throughout the hive by workers, physiologically suppresses the development of ovaries in the female worker population. If the queen is lost, the absence of QMP eventually allows some workers to begin laying unfertilized, haploid eggs.

23. (B) It significantly increases genetic diversity and colony disease resistance
Polyandry, the practice of a queen mating with multiple drones, introduces high genetic diversity into the worker population. This variation creates "sub-families" within the hive, which enhances the colony's overall resistance to diseases and parasites. Furthermore, increased genetic diversity improves the efficiency of the division of labor, as different workers may be genetically predisposed to specific tasks.

24. (C) Homozygosity at the complementary sex determiner (csd) locus
The sex of a honey bee is determined by the complementary sex determiner (csd) locus. Females are heterozygous at this locus, while haploid drones are hemizygous. However, if an egg is homozygous at the csd locus due to inbreeding, it develops into a diploid drone. These diploid drones are typically identified and consumed by worker bees shortly after they hatch.

25. (D) Queen - Diploid (32 chromosomes)
In Apis mellifera, females are diploid organisms possessing 32 chromosomes. This includes both the queen, who is the primary reproductive female, and the workers, who are non-reproductive females. Drones, being the result of arrhenotokous parthenogenesis from unfertilized eggs, are haploid and possess only 16 chromosomes. These chromosome counts are essential for the genetic stability and reproduction of the colony.

26. (A) I, III and IV
The queen controls the sex of her offspring by regulating sperm release during oviposition. Female caste differentiation is influenced by the mTOR pathway, which responds to the quality of larval nutrition. Drones are haploid, possessing 16 chromosomes inherited from the queen. However, not all female larvae receive royal jelly throughout their entire development; workers are switched to a different diet.

27. (B) 3 days for all castes
Regardless of their future caste or sex, all honey bee eggs in an Apis mellifera colony typically hatch after a period of three days. During this time, the embryo develops within the eggshell until it emerges as a tiny, white larva. This consistency in the incubation period provides a predictable timeline for beekeepers monitoring the health and growth of the brood.

28. (B) 21 days
The total developmental period for a worker honey bee, from the time the egg is laid until the adult bee emerges from the cell, is approximately 21 days. This cycle includes three days as an egg, about six days in the larval stage, and twelve days as a pupa. Understanding this timeline is crucial for effective hive management and disease control.

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(A) Summer; with the intent to prey on the queen bee
(B) Winter; for warm shelter and to feed on pollen
(C) Monsoon; with the intent to drink the stored nectar
(D) Spring; with the intent to eat the wax moth larvae

2021

157. Toads and frogs can occasionally become problematic in an apiary. What is their typical mode of predation?
(A) Sitting under boards at dusk to snap up returning foragers
(B) Climbing into the super chambers to eat the stored honey
(C) Tunneling under the hive to eat roots of nectar plants
(D) Laying eggs in water feeders to poison the drinking bees

2025

158. Among the various classes of agricultural chemicals, which systemic insecticide group is globally recognized as highly toxic to honey bees and implicated in pollinator decline?
(A) Synthetic Pyrethroid insecticides
(B) Inorganic Organosulfur compounds
(C) Neonicotinoids (e.g., Imidacloprid)
(D) Organic Botanical Neem oil extracts

2006

159. Consider the following strategies for mitigating pesticide toxicity to honey bees in agroecosystems:
I. Applying pesticides as emulsifiable concentrates rather than microencapsulated formulations.
II. Spraying broad-spectrum insecticides during peak blooming periods.
III. Notifying local beekeepers 48 hours prior to the application of hazardous chemicals.
IV. Applying pesticides during the late evening or night when bees are not foraging.
V. Selecting pesticides with high residual toxicity and long half-lives to reduce application frequency.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) II, III and V
(C) I, III and IV
(D) III, IV and V

NODIA

2011

160. To maximize pollinator safety while managing crop pests, what is the best recommended time of day for a farmer to apply necessary non-residual agricultural pesticides?
(A) Early morning, right at the moment of sunrise
(B) Mid-morning, when the temperatures begin to rise
(C) Late evening or night, after foraging has ceased
(D) High noon, in order to maximize the UV degradation

****

(A) Galleria mellonella
(B) Achroia grisella
(C) Oplostomus fuligineus
(D) Vespa mandarinia

2005

148. The primary damage caused by the wax moth (Galleria mellonella) in an apiary is characterized by:
(A) The adults feeding heavily on stored nectar and honey
(B) The larvae boring into the wooden hive box components
(C) Larvae tunneling wax combs leaving silken galleries
(D) The adults attacking and killing the foraging workers

2008

149. Predatory wasps are significant enemies of apiaries during the monsoon and autumn seasons. Which species is well-known for hawking honey bees in mid-air at the hive entrance?
(A) Vespa velutina
(B) Galleria mellonella
(C) Acherontia styx
(D) Braula coeca

2002

150. Which fumigant is widely used to protect stacked, empty honeycombs in storage from wax moth infestations?
(A) Refined Naphthalene balls
(B) Impregnated Amitraz strips
(C) Volatile Calcium cyanide
(D) Paradichlorobenzene (PDB)

2003

151. What is an effective and safe mechanical management strategy to control predatory wasp (Vespa spp.) populations in an apiary?
(A) Broadcasting broad-spectrum insecticides over the apiary
(B) Inverted cone traps baited with sweet liquid or meat
(C) Removing the queen from colonies during the wasp season
(D) Relocating the apiary into a dense and dark forest area

2001

152. Match the following apiary pests/enemies with their primary mode of damage:
List I: (Apiary Enemy)
P. Death's-head hawkmoth (Acherontia styx)
Q. Wax moth (Galleria mellonella)
R. Bee Louse (Braula coeca)
S. Predatory Wasps (Vespa spp.)
List II: (Mode of Damage)
1. Commensal wingless fly; steals food from the mouthparts of bees (especially queens)
2. Enters hives at night to consume honey directly from combs
3. Decimates the foraging force by preying on adult bees at the entrance
4. Destroys the structural integrity of the beeswax combs
(A) P-1, Q-4, R-2, S-3
(B) P-3, Q-1, R-4, S-2
(C) P-4, Q-2, R-1, S-3
(D) P-2, Q-4, R-1, S-3

2016

153. Which of the following bird species is a specialized, major predator of honey bees on the wing in India?
(A) Indian Peafowl (Pavo cristatus)
(B) House Sparrow (Passer domesticus)
(C) Rock Pigeon (Columba livia)
(D) Green Bee-eater (Merops orientalis)

2024

154. In high altitude and forested regions of India, bears pose a severe threat to apiaries. How do bears primarily cause damage?
(A) Smashing hives to eat brood, honey, and bees
(B) They meticulously extract only the single queen bee
(C) They introduce fungal pathogens through their thick fur
(D) They exclusively prey on the flying bees outside the hive

2006

155. What is the most practical, non-chemical apiary management practice to protect honey bee colonies from severe ant attacks?
(A) Spraying the hive interior with systemic insecticides
(B) Elevating hives on stands with legs in water or oil
(C) Replacing wooden bottom boards with solid zinc plates
(D) Keeping the entire apiary area flooded with deep water

2017

156. Rodents, such as mice, typically invade bee hives during which season, and what is their primary objective?

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is a specialized structure used specifically for cleaning the antennae.

10. (A) Ovipositor
The honey bee sting is an evolutionary modification of the ovipositor, which is the egg-laying organ found in many female insects. In aculeate Hymenoptera, such as bees, wasps, and ants, this structure has transitioned from a reproductive tool to a defensive apparatus. Consequently, only female bees possess a sting, while the males entirely lack this specific anatomical feature.

11. (B) Retrorse barbs on the paired lancets
The worker honey bee's sting shaft contains paired lancets equipped with tiny, backward-pointing retrorse barbs. When the sting penetrates the elastic skin of a mammal, these barbs act like a fishhook, anchoring the apparatus firmly into the tissue. This mechanical design prevents the bee from withdrawing the sting, ultimately resulting in the loss of the apparatus during defensive encounters.

12. (A) Both A and R are true and R is the correct explanation of A.
Worker honey bees possess a barbed sting that becomes lodged in the skin of vertebrates. When the bee attempts to fly away after stinging, the anchored apparatus is pulled out of its body along with the venom sac and internal organs. This severe abdominal rupture is fatal to the worker, serving as a classic example of altruistic defensive behavior.

13. (A) Nasonov gland
The Nasonov gland is located on the dorsal surface of the worker bee's abdomen. It secretes a mixture of volatile terpenoids, including geraniol and citral, which act as an orientation pheromone. By fanning their wings at the hive entrance, bees disperse these chemicals to guide returning foragers, swarms, or lost bees back to the safety of the colony.

14. (C) Biosynthesis of major components of royal jelly
The hypopharyngeal glands, located in the heads of young worker bees known as nurse bees, are highly developed for the production of royal jelly. This protein-rich secretion is essential for feeding the queen and young larvae during their early developmental stages. The activity of these glands is closely linked to the worker's age and the nutritional needs of the brood.

15. (D) Ventral sternites 4 to 7
Honey bee wax glands are specialized epidermal structures located on the ventral side of the worker's abdomen. They are found on the fourth, fifth, sixth, and seventh abdominal sternites. These glands secrete liquid wax that hardens into small, transparent flakes known as wax scales, which are then harvested and used by the bees to construct and repair honeycombs.

16. (C) Production of 9-ODA to attract drones and inhibit worker ovaries
The mandibular glands of a queen honey bee produce 9-oxo-2-decenoic acid (9-ODA), a primary component of queen mandibular pheromone. This chemical signal is vital for attracting drones during mating flights and plays a critical role inside the hive by suppressing the development of ovaries in worker bees. It ensures the queen remains the sole reproductive individual within the colony.

17. (B) The arolium of the tarsus on each leg
Arnhart glands, commonly called footprint glands, are situated on the arolium of the tarsal segment of all six legs. These glands secrete a persistent pheromone every time the bee lands or walks. This chemical trail helps workers recognize the hive entrance and mark profitable food sources, contributing to the overall coordination of foraging activities within the bee colony.

NODIA

18. (D) Dufour's gland secretion coats eggs for protection and royal signaling
Dufour's gland, located near the sting apparatus, produces secretions that serve various signaling functions. In queens, this secretion is used to coat eggs, allowing workers to distinguish between eggs laid by the queen and those potentially laid by workers. This chemical marking is essential for maintaining social order and ensuring that only the queen's offspring are reared by the colony.

19. (A) P-2, Q-4, R-1, S-3
The Nasonov gland produces geraniol and citral for orientation. Worker mandibular glands secrete 2-heptanone, which acts as an alarm signal or anesthetic. The Koschevnikov gland, associated with the sting, produces isopentyl acetate to trigger defensive behavior. Meanwhile, the

ANSWERS

1. (B) Suborder Apocrita, Superfamily Apoidea
Honey bees are classified within the suborder Apocrita, which is characterized by a narrow waist or petiole between the thorax and abdomen. They belong to the superfamily Apoidea, which includes all bees and certain wasps. This taxonomic hierarchy correctly places them among other hymenopterans based on shared morphological traits and common evolutionary ancestors within the order Hymenoptera.

2. (D) Apinae
The genus Apis is located within the subfamily Apinae, which is part of the larger family Apidae. This subfamily encompasses various corbiculate bees, including honey bees, orchid bees, and bumble bees. Members of Apinae are distinguished by their social structures and specific morphological features, such as the pollen-carrying structures found on the hind legs of the worker bees.

3. (A) Stingless bees (Meliponini) are structurally entirely unrelated to the Apini tribe.
Stingless bees and honey bees are both members of the family Apidae and share a common evolutionary lineage. Both groups exhibit advanced eusocial behavior and belong to the monophyletic group known as corbiculate bees. Claims that they are structurally unrelated are biologically inaccurate, as they share fundamental morphological traits, including the possession of specialized structures for pollen collection.

4. (C) Chewing-lapping mouthparts and specialized plumose body hairs
The superfamily Apoidea is distinguished from other hymenopteran groups by specialized morphological adaptations for nectar and pollen collection. These include chewing-lapping mouthparts, which facilitate the intake of liquids and solids. Furthermore, the presence of plumose or branched body hairs is a unique feature that allows these insects to effectively trap and transport pollen grains between different flowering plants.

5. (C) I and II
Worker honey bees in the genus Apis possess a specialized corbicula on their hind tibia for pollen storage. Members of the suborder Apocrita are defined by the petiole, often referred to as the wasp waist. However, honey bees belong to the tribe Apini rather than Meliponini. Therefore, the descriptions of the corbicula and suborder traits are biologically correct.

6. (D) Glossa, galeae, and labial palps
The functional tongue of a honey bee is a complex integrated structure designed for lapping nectar. It is primarily composed of the elongated glossa, which is surrounded by the paired galeae and the labial palps. Together, these parts form a tube through which liquid food is drawn by capillary action and muscular contractions, allowing for efficient feeding from flowers.

7. (B) Coupling forewings and hindwings for synchronized flight
Hamuli are microscopic, hook-like structures located on the anterior margin of the hindwing. During flight, these hooks engage with a fold on the posterior margin of the forewing. This physical coupling ensures that both pairs of wings function as a single unit, significantly improving aerodynamic efficiency, flight stability, and the ability of the bee to carry heavy loads.

8. (C) Scape, pedicel, flagellum
The geniculate antennae of the worker honey bee consist of three primary parts in a specific sequence. The long, basal segment is the scape, followed by a small, elbow-like joint called the pedicel. The remainder of the antenna is the flagellum, which is composed of multiple segments containing numerous sensory receptors for detecting chemical signals, vibrations, and humidity changes.

9. (D) Foreleg - Rastellum for compacting propolis
The anatomical description of the foreleg is inaccurate because the rastellum is actually located on the hind leg of the worker bee. The rastellum, along with the auricle, is used to rake and pack pollen into the corbicula. In contrast, the foreleg is characterized by the strigilis, which

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29. (A) Defecation and spinning of a silken cocoon by the larva
The transition from the larval to the prepupal stage occurs after the worker bees cap the cell. Once enclosed, the larva defecates to empty its digestive tract and begins spinning a delicate silken cocoon. This stage marks the end of active feeding and the beginning of the internal transformations that will eventually result in the formation of the adult bee's body.

30. (C) Histolysis of larval tissues and histogenesis of adult structures
The pupal stage is a period of intense biological reorganization within the capped cell. During this phase, larval tissues undergo histolysis, which is the process of breaking down, while adult structures like wings, legs, and compound eyes are formed through histogenesis. This metamorphosis completely reshapes the insect, transforming it from a simple worm-like larva into a complex, highly specialized adult.

31. (B) Eyes turn pink, purple, and brown before body pigmentation occurs
Pigmentation in the honey bee pupa follows a very specific and predictable chronological order. The compound eyes are the first structures to show color, transitioning from white to pink, then purple, and finally dark brown. Only after the eyes have darkened significantly does the rest of the body, including the thorax and abdomen, begin to develop its final adult coloration.

32. (C) Large compound eyes that meet at the top of the head
A drone pupa can be easily distinguished from a worker pupa by its prominent compound eyes, which are much larger and meet at the top of the head. This anatomical feature is an adaptation that provides drones with superior vision, which is essential for spotting and pursuing queens during mating flights. Workers have smaller eyes that are positioned on the sides of the head.

33. (B) Egg → Larva → Prepupa → Pupa → Adult
Honey bees undergo complete metamorphosis, which consists of four distinct biological stages. The life cycle begins with the egg, followed by the larval stage where rapid growth occurs. After the cell is capped, the insect enters the prepupal and then the pupal stage, where adult structures develop. Finally, the fully formed adult bee emerges from the honeycomb cell to begin its duties.

34. (D) A single, large, open-air comb on high branches or cliffs
Apis dorsata, frequently referred to as the giant rock bee, is known for its unique open-air nesting behavior. It constructs a single, massive comb that can be over a meter in length. These nests are typically attached to high, inaccessible structures such as cliff faces, tall buildings, or the thick branches of large trees, providing protection from many ground-based predators.

35. (A) Apis cerana
Apis cerana is the indigenous honey bee species of India that naturally nests in dark cavities, such as hollow tree trunks or rock crevices. Because of this cavity-nesting habit, it is well-suited for management in modern movable-frame hives. It has a long history of traditional beekeeping in India and is valued for its ability to thrive in diverse local agro-climatic conditions.

36. (C) It is the most productive yielder among indigenous Apis species
Apis florea, the dwarf honey bee, is the smallest of the Apis species and is known for its nomadic behavior and open-air nests. However, it is not the most productive yielder; its honey production is quite low compared to Apis cerana and Apis dorsata. It is primarily valued for the high medicinal quality of its honey rather than for large-scale commercial volume.

37. (A) Rearing brood in hexagonal cells while storing honey in resin pots
Stingless bees, belonging to the tribe Meliponini, exhibit a unique nest architecture that differs significantly from the genus Apis. While they rear their brood in horizontal or spiraling layers of hexagonal cells, they do not store food in these cells. Instead, they construct large, egg-shaped pots made of cerumen, a mixture of wax and plant resin, to store honey and pollen.

38. (D) Shimmering behavior (coordinated body shaking) to deter wasps
Apis cerana exhibits a specialized collective defense mechanism known as shimmering. When a predator like a wasp approaches the nest, the bees perform coordinated waves of body shaking across the surface of the comb or entrance. This visual display creates a flickering effect that

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three days; instead, they are transitioned to a diet containing more honey and pollen.

76. (C) 61°C - 65°C
Pure beeswax is characterized by a specific melting point range, typically falling between 61°C and 65°C. This physical property is a reliable indicator of its purity and is used by beekeepers and industries to detect the presence of adulterants like paraffin or tallow, which have different melting points. Proper processing ensures the wax retains its structural integrity and unique properties for various applications.

77. (A) Treatment of severe acute bacterial meningitis
Bee venom therapy, or apitherapy, is utilized for its anti-inflammatory and analgesic properties in managing conditions like rheumatoid arthritis and for desensitizing individuals with bee sting allergies. However, it is not a recognized or appropriate treatment for severe acute bacterial meningitis, which requires urgent conventional medical intervention with antibiotics. Claims regarding its use for such critical infectious diseases are not supported by medical science.

78. (C) Melittin
Melittin is the most abundant peptide in honey bee venom, making up approximately 50% of its dry weight. It is a powerful surfactant that disrupts cell membranes, causing cell lysis and pain during a sting. Melittin also exhibits various biological activities, including anti-inflammatory and potential anticancer effects, which are subjects of ongoing scientific research into the therapeutic applications of bee venom components.

79. (D) Maceration and dissolution in high-proof ethanol
The standard commercial method for extracting and purifying propolis involves macerating the raw hive scrapings in high-proof ethanol. Because the active resinous and balsamic compounds in propolis are highly soluble in alcohol but not in water, this solvent-based extraction allows for the efficient removal of impurities like wax and wood. The resulting tincture can then be used in various medicinal and health products.

80. (C) Royal Jelly
10-hydroxy-2-decenoic acid (10-HDA) is a unique fatty acid found exclusively in royal jelly. Because it does not occur naturally in any other substance, it serves as the definitive chemical marker for assessing the authenticity and quality of royal jelly products. Measuring the concentration of 10-HDA allows laboratories to ensure that royal jelly has not been diluted or substituted with other materials.

81. (B) Entomophily
Entomophily is the specialized mode of pollination where insects, particularly honey bees, serve as the primary agents for transferring pollen from the male anthers to the female stigma of flowers. This mutualistic relationship is vital for the reproduction of many plant species. Honey bees are among the most effective entomophilous pollinators due to their foraging behavior and morphological adaptations for pollen transport.

82. (A) Both A and R are true and R is the correct explanation of A.
Honey bees are exceptionally efficient pollinators because they exhibit floral fidelity, also known as flower constancy. During a single foraging trip, an individual bee will consistently visit flowers of the same species. This behavior ensures that pollen is transferred between compatible plants of the same species, maximizing the chances of successful fertilization and increasing the overall efficiency of the pollination process.

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83. (A) Almond
The almond crop is almost entirely dependent on honey bee cross-pollination to achieve a commercial fruit set. Because almond flowers are self-incompatible, they require the transfer of pollen between different varieties by insects. Honey bees are the primary pollinators used in almond orchards worldwide, and their presence is essential for ensuring high yields and quality nut production in large-scale agricultural systems.

84. (C) Highly branched, plumose hairs covering the body
Honey bees are covered in specialized plumose or branched hairs that are particularly effective at trapping pollen grains. As the bee moves within a flower to collect nectar or pollen, these hairs physically brush against the anthers, picking up thousands of pollen grains. This morphological adaptation, combined with the bee's foraging behavior, makes them highly efficient agents for the cross-pollination of numerous plant species.

culminating in the departure of the prime swarm from the original hive.

48. (C) Swarming divides colonies, while absconding involves the whole hive
Swarming is a natural reproductive process where a colony divides, with the old queen and a portion of the workers leaving to establish a new nest. In contrast, absconding is a defensive or survival response where the entire colony, including all adult bees and the queen, abandons the hive due to severe stress, such as pest infestation or lack of food.

49. (B) Replacement of an old queen by a new one without division
Supersedure is the natural process where a honey bee colony replaces an aging, failing, or injured queen with a young one. Unlike swarming, supersedure does not involve the division of the colony or the departure of a swarm. The workers rear a few queen cells, and once the new queen emerges and mates, she eventually takes over the egg-laying duties.

50. (D) Scattered on the face (surface) of the comb
During the supersedure process, the workers typically construct only a small number of queen cells. These cells are usually located on the face or surface of the brood comb, rather than along the bottom edges where swarm cells are often found. This positioning is a key diagnostic feature that helps beekeepers distinguish between the colony's intent to swarm or supersede.

51. (A) Low Queen Mandibular Pheromone (QMP) levels among workers
The primary trigger for swarming in a congested colony is the dilution or insufficient distribution of Queen Mandibular Pheromone (QMP). When the hive becomes overcrowded, the pheromone produced by the queen cannot reach all the workers effectively. This drop in perceived QMP levels signals to the workers that the queen is failing or the hive is too small, initiating swarm cell construction.

52. (B) 5 to 10 days
A virgin queen typically reaches sexual maturity and undertakes her mating flights between five and ten days after emerging from her cell. These flights are dependent on favorable weather conditions, requiring warm temperatures and low wind. During this critical window, the queen will mate with multiple drones in the air to collect enough sperm to last her entire reproductive lifespan.

53. (A) In aerial zones known as Drone Congregation Areas (DCAs)
Honey bee mating occurs exclusively in flight within specific aerial locations called Drone Congregation Areas. These areas are geographic hotspots where drones from various surrounding colonies gather in large numbers. Virgin queens fly to these zones to mate with multiple drones, ensuring high genetic diversity within the colony's future worker population while avoiding the risks of inbreeding with drones from their own hive.

54. (C) A is true but R is false.
The waggle dance is a sophisticated form of communication that conveys both the direction and distance of a food source to other foragers. However, the reason provided is incorrect because the round dance is actually performed when the food source is very close to the hive, typically within 50 to 100 meters, rather than at longer distances.

55. (B) The distance of the food source from the hive
In the waggle dance, the duration of the straight waggle run is the primary indicator of distance. A longer duration of the waggle phase signifies a greater distance to the food source. Bees use this temporal information, combined with the energy expended during flight, to precisely locate resources that have been identified by scout bees, allowing for efficient recruitment of the colony's foragers.

56. (C) Angle to gravity represents food angle relative to the sun
When honey bees perform the waggle dance on a vertical comb in the darkness of the hive, they use gravity as a reference for the sun's position. The angle of the waggle run relative to the vertical line represents the angle of the food source relative to the sun. This allows the bees to communicate complex navigational directions without needing visual cues.

57. (D) Temporal polyethism where duties change with worker age
Division of labor in honey bees is governed by temporal polyethism, where workers transition

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confuses the predator, making it difficult for the wasp to target and capture individual honey bees.

39. (B) Varroa mites exclusively reproduce in the drone brood of Apis cerana.
Apis cerana has a unique co-evolutionary relationship with Varroa destructor that limits the parasite's impact. In this species, the mites are generally restricted to reproducing within the drone brood, where they have less effect on the overall colony strength. Furthermore, the worker bees exhibit high grooming and hygienic behaviors, effectively removing mites from themselves and the brood, preventing devastating infestations.

40. (C) I, IV and V
Apis dorsata is an extremely aggressive and defensive bee, making it unsuitable for docile backyard beekeeping. Furthermore, its workers are much larger than those of the dwarf bee, Apis florea. In commercial settings, the honey yield from an Apis mellifera colony is generally much higher than that of Apis cerana, making the first, fourth, and fifth statements factually incorrect.

41. (B) 1962
The successful introduction and establishment of the European honey bee, Apis mellifera, in India was achieved in 1962. This milestone was led by Dr. A.S. Atwal at the Punjab Agricultural University. This introduction revolutionized Indian beekeeping by providing a species with higher honey production potential and better suitability for commercial management compared to the indigenous cavity-nesting species available at that time.

42. (A) Apis mellifera ligustica
The Italian honey bee, Apis mellifera ligustica, was the primary subspecies introduced into India. It was selected for its desirable traits, including a prolific queen, a gentle temperament, and a low tendency to swarm or abscond. Its ability to build large populations rapidly and forage efficiently on various crops made it the ideal choice for establishing a modern commercial beekeeping industry.

43. (B) Nagrota Bagwan, Himachal Pradesh
The first successful establishment of Apis mellifera in India took place at Nagrota Bagwan, located in the Kangra Valley of Himachal Pradesh. This region provided a favorable climate and sufficient floral resources for the initial colonies to thrive and multiply. From this successful introduction site, the species was eventually distributed to other parts of northern India and then throughout the country.

44. (B) Predatory wasps, native wax moths, and viral diseases
The introduction of Apis mellifera into India faced significant biological hurdles. The colonies were highly susceptible to local predators, particularly various species of large wasps and the greater wax moth. Additionally, the lack of natural resistance to indigenous viral diseases and the presence of parasitic mites required the development of new management techniques to ensure the long-term survival of the European bees.

45. (A) A prolific queen and larger colony population size
Apis mellifera is preferred for large-scale commercial beekeeping because its queens are highly prolific, leading to significantly larger colony populations. A larger workforce allows the colony to collect more nectar and pollen, resulting in higher honey yields per hive. Additionally, this species shows a lower tendency to abscond compared to Apis cerana, ensuring greater stability for the commercial beekeeper.

NODIA

46. (C) Foraging at specific times to avoid high summer heat
As Apis mellifera adapted to the Indian climate, it developed specific behaviors to cope with environmental stresses. In regions with extreme summer temperatures, the bees adjust their foraging patterns, becoming more active during the cooler early morning and late afternoon hours. This temporal adjustment helps the bees avoid heat stress and prevents excessive water loss, ensuring the colony remains productive during hot periods.

47. (A) I → II → III → IV → V
Reproductive swarming follows a structured biological sequence within the colony. It begins with the rearing of drones, followed by the construction of queen cups. As new queens develop, the old queen's egg-laying decreases to facilitate flight. Workers then engorge themselves with honey to provide energy for the journey,

pheromone marks the intruder, providing a chemical beacon that directs other bees to the exact location of the threat, resulting in a rapid and coordinated colony defense.

67. (B) 20%
According to the AGMARK standards in India, the maximum permissible moisture content for Special Grade honey is 20%. Maintaining a moisture level below this threshold is critical for preventing the fermentation of honey by osmophilic yeasts. This standard ensures that the honey remains shelf-stable and maintains its quality during storage and distribution in the commercial marketplace, benefiting both producers and consumers.

68. (C) III only
Hydroxymethylfurfural is a chemical compound that forms naturally in honey through the breakdown of fructose. High levels of HMF are not indicative of fresh honey; instead, they serve as a clear indicator of excessive heating, improper storage conditions, or old age. Therefore, the statement claiming that high HMF content signifies freshly harvested, unheated honey is factually incorrect and contradicts established quality standards.

69. (A) Hydroxymethylfurfural (HMF)
FSSAI monitors Hydroxymethylfurfural levels as a primary indicator of honey quality and authenticity. HMF content increases when honey is heated to high temperatures during processing or when it is stored for long periods in warm climates. Because fresh, raw honey contains very little HMF, elevated levels are used by regulatory authorities to detect over-processing, adulteration with invert sugars, or significant degradation of the product.

70. (D) High glucose-to-water ratio and glucose precipitation
The granulation or crystallization of honey is a natural physical process primarily driven by its high sugar concentration. Honey is a supersaturated solution, and glucose, being less soluble than fructose, tends to precipitate out of the solution. A high glucose-to-water ratio accelerates this process, leading to the formation of glucose monohydrate crystals that give the honey a solid or grainy texture over time.

71. (B) 1.35
The specific gravity of honey is a measure of its density compared to water and is directly influenced by its moisture content. For well-ripened honey at a standard temperature of 27°C, the specific gravity should not be less than 1.35. A higher specific gravity indicates lower moisture content, which is a key requirement for high-quality honey that is resistant to fermentation and spoilage.

72. (C) Glucose oxidase
The inherent antibacterial property of honey is largely attributed to the activity of the enzyme glucose oxidase, which is added by the bees. This enzyme breaks down glucose into gluconic acid and hydrogen peroxide. The slow, continuous release of hydrogen peroxide provides a powerful antimicrobial effect that inhibits the growth of various bacteria and fungi, contributing to the long-term preservation of honey.

73. (D) Fructose and Glucose
Fructose and glucose are the two primary monosaccharides found in honey, collectively accounting for the majority of its solid weight. The relative proportions of these two sugars vary depending on the floral source, but fructose is typically the more abundant of the two. These simple sugars are easily digested and provide the immediate energy source that honey bees require for flight and other metabolic activities.

74. (A) Resinous exudates collected from the buds and bark of trees
Propolis is a resinous substance that honey bees collect from various botanical sources, including tree buds and bark exudates. After collection, the bees mix these resins with small amounts of wax and salivary secretions to create a durable "bee glue." Propolis is used within the hive for sealing gaps, reinforcing combs, and providing a powerful antimicrobial barrier that protects the colony from pathogens.

75. (D) I, II, and IV
Royal jelly is secreted by the hypopharyngeal and mandibular glands of nurse bees and contains the unique fatty acid 10-HDA. It possesses significant antimicrobial properties and is essential for queen development. However, the third statement is incorrect because royal jelly is not fed exclusively to drone larvae after

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through different tasks as they age. Young bees typically perform indoor duties like cleaning and nursing. As they mature, they move to tasks such as comb building and guarding, eventually becoming foragers in the final stage of their lives. This flexible system ensures all colony needs are met efficiently.

58. (A) Processing optic flow of visual patterns across the retina
Honey bees measure the distance to a food source by monitoring the optic flow, which is the rate at which visual images move across their eyes during flight. By integrating this visual information, the bee can calculate the distance traveled regardless of wind speed. This mechanism provides a highly accurate way for foragers to navigate and communicate food locations to their colony members.

59. (B) More foragers collect pollen for larval protein demands
Honey bee colonies possess a sophisticated feedback system to maintain nutritional balance. When pollen stores become depleted, the colony rapidly adjusts its foraging priorities. Chemical signals from the brood and a lack of pollen in the hive trigger more foragers to specifically seek out and collect pollen rather than nectar. This ensures that the developing larvae receive the protein necessary for their growth.

60. (B) Waggle Dance - Karl von Frisch
The intricate communicative dances of honey bees, including the round and waggle dances, were decoded by the ethologist Karl von Frisch. His groundbreaking research demonstrated how bees use these movements to share precise information about the location and quality of resources. For this discovery, which revealed the complexity of insect communication, he was awarded the Nobel Prize in Physiology or Medicine in 1973.

61. (D) P-2, Q-3, R-1, S-4
Queen mandibular pheromone 9-ODA inhibits queen rearing, while isopentyl acetate from the sting apparatus serves as the primary alarm signal. Brood Ester Pheromone from larvae regulates nurse bee feeding, and E-beta-ocimene, another larval signal, inhibits worker ovary development. This complex network of pheromones ensures that the social structure, reproduction, and foraging activities of the colony are maintained in a highly coordinated manner.

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62. (C) Isopentyl acetate
Isopentyl acetate is the primary active chemical component of the honey bee's alarm pheromone. Produced by the Koschevnikov gland near the sting apparatus, it is released when a bee stings or is threatened. This volatile compound has a distinct odor similar to bananas and serves to quickly alert and recruit other bees to defend the hive against a perceived intruder or predator.

63. (D) Queen Mandibular Pheromone (QMP)
Queen Mandibular Pheromone is a complex mixture of chemicals that is essential for colony cohesion. It attracts a group of "retinue" workers that groom and feed the queen, subsequently spreading the pheromone throughout the hive. QMP acts as a powerful social signal, suppressing worker reproduction and preventing the rearing of new queens, thereby maintaining the established hierarchy within the bee colony.

64. (C) Local anesthetic used to paralyze small intruders
Worker honey bees secrete 2-heptanone from their mandibular glands. While once thought to be an alarm pheromone, research has shown it acts as a local anesthetic. When a bee bites a small intruder that is too small to sting, such as a wax moth larva or a Varroa mite, the chemical temporarily paralyzes the pest, allowing the bee to remove it from the hive.

65. (B) The larval requirement for proteinaceous food
Brood Ester Pheromone is a blend of fatty acid esters emitted by developing honey bee larvae. This pheromone acts as a primer and releaser, communicating the nutritional needs of the brood to the adult workers. High levels of BEP signal a strong demand for protein, which stimulates workers to increase their pollen foraging efforts to ensure the larvae are adequately fed for healthy development.

66. (D) Lowering defensive thresholds and directing bees to targets
The release of sting pheromone during a defensive encounter significantly alters the behavior of nearby honey bees. The volatile chemicals lower the defensive threshold of other workers, making them more likely to attack. Furthermore, the

85. (A) Rice - 5 to 7 colonies/ha
The pairing of rice with a recommended colony density for pollination is incorrect because rice is primarily a self-pollinated or wind-pollinated crop. It does not require insects like honey bees for pollination or fruit set. In contrast, crops like apples, sunflowers, and alfalfa have established recommended colony densities because they are significantly dependent on honey bee activity to achieve optimal commercial yields and quality.

86. (D) Tripping mechanism
Alfalfa flowers possess a specialized "tripping" mechanism that must be activated for pollination to occur. When a bee enters the flower, the sexual column is forcefully released, striking the bee and depositing pollen. While honey bees can be reluctant to trip alfalfa because of this forceful mechanism, they are still vital pollinators. This unique interaction ensures that pollen is transferred effectively between flowers in the alfalfa field.

87. (B) When 10% to 20% of the blossoms have opened
In apple orchards, the optimal time to introduce honey bee colonies for pollination is when approximately 10% to 20% of the blossoms have opened. Placing the hives at this stage ensures that the bees are present as the main bloom begins, while also minimizing the risk of the bees being lured away by other competing flora that might be blooming earlier in the surrounding landscape.

88. (C) Collective vegetation providing nectar and pollen
The term "bee pasturage" or "bee flora" refers to the entire range of plants that provide nectar and pollen for honey bees. This includes cultivated crops, wild herbs, weeds, and forest trees. A diverse and abundant bee flora is essential for the health and productivity of the colony, as it ensures a continuous supply of the carbohydrates and proteins necessary for the bees' survival.

89. (D) P-3, Q-2, R-1, S-4
Mustard provides both rich nectar and abundant pollen, while rubber is a major nectar source primarily through extra-floral nectaries. Maize is a significant source of pollen but yields no nectar. Eucalyptus species are known for being major nectar producers while also providing good amounts of pollen. Understanding these different floral rewards is essential for beekeepers to manage their colonies and plan for honey production.

90. (A) To plan migration, feeding, and honey harvest schedules
A floral calendar is a vital management tool in apiculture that records the blooming periods of major and minor bee flora in a specific region. By using this calendar, beekeepers can accurately plan when to migrate hives to new locations, when to provide supplemental feeding during dearth periods, and when to expect major honey flows for harvesting, ensuring optimal productivity throughout the year.

91. (B) Wheat (Triticum aestivum)
Wheat is a wind-pollinated cereal crop and does not produce nectar to attract insects. While honey bees may occasionally collect pollen from wheat if other sources are scarce, it is generally considered a non-yielding or minor source of forage for them. In contrast, crops like litchi, ber, and jamun are major nectar-yielding plants that are highly attractive to honey bees and produce significant honey crops.

92. (B) Wild herbs, weeds, and minor forest flora
During the dearth period, when major nectar-yielding crops are not in bloom, honey bee colonies rely heavily on wild herbs, weeds, and minor forest flora for their survival. Although these plants may not provide enough surplus nectar for honey harvesting, they offer essential maintenance supplies of pollen and nectar that help keep the colony alive and the queen laying until the next major bloom.

93. (A) Rhododendron spp.
Some species of Rhododendron produce nectar containing grayanotoxins, which can be toxic to honey bees and potentially humans if the honey is consumed in large quantities. While bees often forage on these plants when other sources are scarce, heavy feeding can lead to bee mortality. Understanding which local plants are potentially toxic is important for beekeepers when selecting apiary sites and managing colony health.

94. (D) 482 mm x 232 mm
The standard Langstroth brood frame, used globally in modern beekeeping, has specific external dimensions of approximately 482 mm in length and 232 mm in depth. These

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113. (B) To stimulate queen laying and accelerate colony build-up
Stimulative feeding involves providing light sugar syrup to a colony in early spring to mimic a natural nectar flow. This extra food source signals to the queen that resources are becoming abundant, encouraging her to increase egg production. The resulting rapid increase in the worker population ensures the colony is strong enough to take full advantage of the major nectar flows when they eventually begin.

114. (D) Spreading water over combs and fanning for cooling
During extreme summer heat, honey bees employ evaporative cooling to maintain a stable internal temperature in the brood nest. Workers collect water and spread it in thin films over the combs and cell rims. Other bees then fan their wings vigorously to create air currents that evaporate the water, effectively lowering the temperature and preventing the delicate brood from overheating and dying.

115. (A) Starvation, humidity, and outbreaks of fungal diseases
The monsoon season in India presents significant challenges for beekeeping management. Heavy rains restrict foraging activity, which can quickly lead to the depletion of food stores and colony starvation. Furthermore, the resulting high internal hive humidity increases the risk of fungal disease outbreaks. Beekeepers must ensure colonies have adequate food reserves and provide proper ventilation and protection from rain during this period.

116. (C) Conserve colony heat and reduce the consumption of winter honey stores
In cold climates or high altitudes, winter packing or insulation is used to help honey bee colonies conserve metabolic heat. By reducing heat loss, the bees do not have to consume as much of their stored honey to maintain the cluster's temperature. This management practice increases the chances of colony survival through the winter and ensures they emerge in the spring with adequate resources.

117. (A) Both A and R are true and R is the correct explanation of A.
During the monsoon season in India, persistent heavy rains often prevent honey bees from foraging for several days or weeks. Without the ability to collect fresh nectar and pollen, colonies can rapidly exhaust their internal food stores. Artificial sugar feeding is therefore a critical management intervention to prevent the death of the colony by starvation and to maintain its overall health.

118. (D) Reversing brood chambers and providing supers for space
To prevent swarming in a strong colony, beekeepers must manage the available space within the hive. Reversing the positions of the brood chambers and adding extra honey supers provides the colony with more room to expand and store nectar. This reduces congestion and ensures that the Queen Mandibular Pheromone is effectively distributed among the workers, thereby suppressing the biological impulse to initiate swarming behavior.

119. (B) Moving colonies to exploit sequential nectar flows
Migratory beekeeping is the practice of moving honey bee colonies to different geographic locations throughout the year. The primary objective is to follow the blooming periods of various major nectar-yielding crops and wildflowers. This strategy allows beekeepers to maximize honey production and provide continuous forage for their bees, ensuring the colonies remains strong and productive across different seasons and regions.

120. (C) A sheet of newspaper with small slits
The newspaper method is a common and effective technique for uniting two honey bee colonies. A single sheet of newspaper with small slits is placed between the two hive bodies. This physical barrier prevents immediate fighting while allowing the different colony odors to mix gradually. By the time the bees chew through the paper, they have acclimated to each other and can merge peacefully.

121. (D) Commercial queen rearing via larval grafting
The Doolittle method is the foundation of modern commercial queen rearing. It involves the precise manual transfer, or grafting, of very young worker larvae into artificial queen cups. These cups are then placed into a queenless or highly motivated "starter" colony, where the workers will feed and develop the larvae into new queens. This technique allows for the mass production of high-quality queens.

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knife. The uncapped frames are then placed in a centrifuge (extractor) to spin out the liquid honey. Finally, the extracted honey is filtered and allowed to settle to remove any remaining impurities before bottling.

104. (C) Slicing wax cappings without tearing the comb structure
Heating the uncapping knife is essential for cleanly removing the wax seals from honeycombs. A hot blade slices through the wax smoothly, similar to cutting through butter, which prevents the delicate hexagonal cell walls from being torn or crushed. This ensures that the beeswax comb remains intact and can be returned to the bees for refilling, saving the colony significant energy and resources.

105. (D) Tangentials require turning frames; radials extract both sides
The primary operational difference between these two types of honey extractors is how the frames are positioned. In a tangential extractor, one side of the frame faces outwards, requiring the beekeeper to stop and flip the frames to extract both sides. In a radial extractor, the frames are arranged like spokes of a wheel, allowing both sides of the comb to be emptied simultaneously.

106. (A) Porter bee escape
The Porter bee escape is a one-way valve inserted into the central hole of the inner cover. It allows worker bees to move down from the honey supers into the brood chamber but prevents them from returning. By placing this device on the hive 24 hours before harvesting, beekeepers can remove honey-filled supers that are completely free of bees, making the harvest process easier.

107. (C) 1851
Reverend L.L. Langstroth discovered the principle of "bee space" and patented his movable-frame hive design in 1851. This discovery revolutionized beekeeping by allowing frames to be easily removed and inspected without destroying the comb or killing the bees. His work forms the basis of modern apiculture, enabling the development of the commercial honey industry and more efficient pollination services for agriculture.

108. (A) 8 mm ($\frac{5}{16}$ inch)
The optimum bee space for Apis mellifera is approximately 8 mm. This is the precise gap that bees recognize as a passage and will not fill with beeswax or propolis. By maintaining this exact spacing between frames and other hive components, beekeepers can ensure that the frames remain easily movable, which is essential for conducting routine inspections and managing the health of the colony.

109. (A) Bees construct irregular burr and brace comb in the gap
If the space between hive components is significantly larger than the natural bee space, the honey bees will attempt to utilize the void by building irregular burr or brace comb. This unwanted wax construction can bridge the gaps between frames, making them difficult to remove during inspections. Proper hive design and frame spacing are necessary to prevent this problem and maintain a manageable hive.

110. (D) II → IV → I → III
A routine colony inspection should begin with a puff of smoke at the entrance to calm the guard bees. Next, the outer roof is lifted, followed by the gentle removal of the inner cover. Finally, the beekeeper removes and inspects the frames, typically starting from the periphery and moving towards the center of the brood nest to monitor the queen and brood health.

111. (D) Deep, damp valleys prone to waterlogging and stagnant air
When choosing a site for an apiary, deep and damp valleys should be avoided because they are often prone to stagnant air and high humidity. These conditions can promote the growth of fungal diseases like chalkbrood and make it difficult for the bees to ripen honey. Ideally, hives should be placed in well-drained areas with good air circulation and easy access to floral resources.

112. (A) 2 to 3 meters
To minimize the problem of "drifting," where bees enter the wrong hive, individual colonies should be spaced at least 2 to 3 meters apart. Proper spacing also helps reduce the rapid spread of pests and diseases between neighboring hives. In addition to spacing, placing hives in irregular patterns or using different colors and landmarks can further help the foragers identify their own home hive.

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standardized measurements ensure that frames are interchangeable between different hive bodies and facilitate the use of mechanical equipment like honey extractors. This standardization was a key factor in the development of efficient and large-scale commercial apiculture.

95. (D) Apis cerana
The Newton hive was specifically designed in India to accommodate the smaller body size and smaller colony populations of the indigenous honey bee, Apis cerana. Its dimensions and frame sizes are scaled down compared to the Langstroth hive to better suit the biological needs of this species, ensuring that the bees can maintain the internal temperature and manage the hive space effectively.

96. (C) II, IV and V
In a standard movable-frame hive, the bottom board provides the base and entrance, the super chamber stores surplus honey, and the inner cover regulates temperature and ventilation. The first statement is incorrect because the required bee space is much smaller than 15 mm, and the third statement is wrong because queen excluders are placed between the brood and super chambers, not the bottom board.

97. (B) Type A is Newton (8 frames), Type B is Jeolikote (10 frames)
The Indian Standards Institution specifications for Apis cerana hives include two primary designs. Type A, known as the Newton hive, is smaller and typically utilizes eight frames. Type B, referred to as the Jeolikote hive, is larger and designed for ten frames. These different types allow beekeepers to choose the hive size that best matches the local environment and the strength of their honey bee colonies.

98. (D) Landing platform for returning foragers at the entrance
The alighting board is a flat surface that extends forward from the hive entrance on the bottom board. It serves as a vital landing platform for returning foragers, especially those heavily laden with nectar and pollen. This structure allows the bees to land safely and walk easily into the hive, reducing the energy expended and the time taken to enter the brood nest area.

99. (A) Inserting bee escapes and aiding feeding or ventilation
The central hole in the inner cover of a hive is a versatile management feature. It allows for the insertion of a Porter bee escape to clear bees from the supers before harvesting. Additionally, it serves as a port for placing feeders directly over the cluster and facilitates vertical ventilation, helping the bees regulate the hive's internal temperature and humidity levels during extreme weather.

100. (C) Teak (Tectona grandis) or Kail (Pinus wallichiana)
Durable and lightweight woods like Teak or Kail are preferred for bee hive construction in India. When properly seasoned, these woods resist warping and decay, providing a stable environment for the colony for many years. Using high-quality wood is essential for maintaining the precise internal dimensions of the hive, such as the bee space, which is critical for the management of movable-frame systems.

101. (A) Physical difference in thorax size between queen and workers
The queen excluder is designed with precise openings that allow worker bees to pass through while physically blocking the larger queen. This difference in thorax size is the key principle behind the tool. By placing the excluder between the brood chamber and the honey super, beekeepers ensure that the queen cannot lay eggs in the super, resulting in frames of pure, clean honey for harvest.

102. (D) Smoke masks alarm pheromones and induces bees to engorge
Using a smoker is a fundamental technique for managing honey bees during inspections. The smoke masks the alarm pheromones released by guard bees, preventing a coordinated defensive response. Additionally, the smoke triggers a survival instinct in the bees, causing them to engorge themselves with honey. Engorged bees are physically less able to sting and are generally much calmer and easier for the beekeeper to handle.

103. (C) II → I → IV → III
The mechanical extraction of honey follows a logical four-step process. First, frames of sealed honey are removed from the supers. Next, the wax cappings are sliced off using a heated

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122. (A) Laying workers due to prolonged queenlessness
In a colony that has been queenless for a long period, some worker bees' ovaries may develop, and they begin to lay eggs. Unlike a queen, laying workers lack the long abdomen to reach the bottom of the cell, so they often attach eggs to the sides. Furthermore, they typically lay multiple eggs in a single cell, all of which will develop into drones.

123. (C) 12 to 24 hours old (1st instar)
For successful queen rearing, the age of the grafted larva is critical. Larvae that are between 12 and 24 hours old are optimal because they have not yet been "programmed" to become workers. At this early stage, the shift to a diet exclusively of royal jelly can fully trigger the physiological changes necessary for the development of a healthy and highly productive queen bee.

124. (D) P-3, Q-4, R-1, S-2
A grafting needle is used to transfer delicate larvae, while a cell protector shields mature queen cells from destruction. Mating nucs are small colonies where virgin queens fly to mate, and the breeder queen is the selected mother whose genetic traits are desired for the next generation. This specialized equipment and terminology are essential for the advanced practice of artificial queen rearing.

125. (A) Starters accept grafts; finishers complete construction
In commercial queen rearing, a two-stage process is often used. The "starter" colony is a highly congested, queenless unit designed specifically to maximize the acceptance and initial feeding of the newly grafted larvae. Once the queen cells have been started, they are moved to a "finisher" colony, which has the necessary resources and worker population to complete the construction and maturation of the cells.

126. (C) Multiply colonies and prevent natural swarming
Artificial division, or "splitting," a strong colony into smaller units (nucs) serves two primary purposes. It allows a beekeeper to increase the total number of colonies in their apiary. Additionally, by removing workers, brood, and the old queen, it effectively reduces the congestion that triggers natural swarming, allowing the beekeeper to maintain control over the colony's growth and reproductive activities.

127. (D) Paenibacillus larvae
American Foulbrood is a highly contagious and devastating disease caused by the spore-forming bacterium Paenibacillus larvae. The spores are extremely resilient, capable of surviving for decades in the environment. Once ingested by young larvae, the bacteria multiply rapidly, eventually killing the host. Because of its severity and the persistence of its spores, AFB is often subject to strict government regulations and quarantine measures.

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128. (C) AFB kills after capping; EFB kills before capping
A primary diagnostic difference between the two diseases is the timing of larval death. In American Foulbrood, the larvae typically die after the cells have been capped by the workers. In contrast, European Foulbrood usually kills the larvae during the coiled stage, before the cells are capped. Recognizing this difference in the brood pattern is essential for beekeepers to accurately identify and treat these diseases.

129. (B) American Foulbrood
The ropiness test is a classic field diagnostic tool for American Foulbrood. A matchstick is inserted into a suspicious, sunken cell and withdrawn. If the dead larval material stretches into a thin, glue-like thread several centimeters long, it confirms the presence of AFB. This characteristic consistency is caused by the specific way the bacterium Paenibacillus larvae breaks down the larval tissues.

130. (D) Sacbrood Virus
Sacbrood virus is characterized by the failure of the larva to pupate. The dead prepupae remain inside the capped cells, appearing as fluid-filled sacs. A unique symptom of this viral infection is the darkening of the head region, while the rest of the body remains light-colored. The "sac" eventually dries out, forming a gondola-shaped scale that can be easily removed by the workers.

131. (C) I and III
Deformed Wing Virus is a serious honey bee pathogen that is primarily vectored and amplified by the Varroa destructor mite. Black Queen Cell Virus is another common viral infection that is frequently associated with

predominate in tropical regions like southern India?
(A) They have an extended diapause period suited for extreme summers in hot regions.
(B) They bypass embryonic diapause.
(C) They exclusively feed on over-matured mulberry leaves found in the forest.
(D) They possess a highly active diapause hormone receptor in their nervous system.

2003

40. Select the correct sequence of voltine expression from the lowest number of generations per year to the highest.
(A) Univoltine → Bivoltine → Polyvoltine
(B) Bivoltine → Univoltine → Polyvoltine
(C) Polyvoltine → Bivoltine → Univoltine
(D) Univoltine → Polyvoltine → Bivoltine

2010

41. If bivoltine eggs are incubated at a low temperature (15°C) and under short-day conditions (darkness), what will be the nature of the eggs laid by the resulting adult moths?
(A) They will be heavily diapausing eggs.
(B) They will be non-diapausing eggs.
(C) They will be sterile eggs.
(D) They will instantly hatch within the female's body.

2006

42. In the context of diapause regulation, what is the biochemical target of the diapause hormone in the developing ovaries?
(A) Inhibiting the synthesis of chorion proteins
(B) Enhancing glycogen conversion to sorbitol and glycerol
(C) Promoting the rapid degradation of ecdysone
(D) Blocking the uptake of water into the oocytes

2004

43. Which pair correctly matches the endocrine hormone with its primary physiological function in the silkworm?
(A) Ecdysone - Induces moulting and cuticle shedding
(B) Juvenile Hormone - Triggers the spinning of the cocoon
(C) Brain Hormone (PTTH) - Inhibits larval growth
(D) Diapause Hormone - Promotes early pupation

2003

44. The prolonged application of a Juvenile Hormone (JH) analogue to fifth instar larvae results in which economic consequence?
(A) Immediate pupation with no silk production occurring in the silk glands.
(B) Formation of extremely small and fragile cocoons that are difficult to reel.
(C) Heavier cocoon weight.
(D) High mortality due to instantaneous dehydration of the larval body tissues.

2023

45. Given below are two statements, one labeled as Assertion (A) and the other labeled as Reason (R).
Assertion (A): A trimoulter silkworm undergoes only three moults during its entire larval span.
Reason (R): The premature cessation of Juvenile Hormone secretion accelerates its metamorphosis into the pupal stage.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2011

46. Under natural conditions, the commercial mulberry silkworm, Bombyx mori, predominantly exhibits which type of moultism?
(A) Trimoulter
(B) Pentamoulter
(C) Tetramoulter
(D) Hexamoulter

2017

47. Which organ is responsible for the synthesis and secretion of Juvenile Hormone in the silkworm?
(A) Corpora cardiaca
(B) Corpora allata
(C) Prothoracic gland
(D) Suboesophageal ganglion

2004

48. What is the observable behavioral sign that a silkworm larva is preparing to enter a moult?
(A) It becomes hyperactive and moves rapidly around the tray in search of more food.
(B) It spins a thick layer of silk over its entire body surface to protect the pupa.
(C) It regurgitates a large volume of green fluid from its digestive tract to cool down.
(D) It anchors itself with its head raised.

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fewer natural defenses, leading to the devastating worldwide infestations seen today.

141. (A) Continuous availability of bee brood
Tropilaelaps mites have a very different life cycle than Varroa. They are much smaller and faster, and they cannot survive for more than a few days on adult bees because they are unable to feed on them. Consequently, Tropilaelaps is entirely dependent on the continuous presence of honey bee brood for its survival and reproduction, making it a particularly severe pest in tropical climates.

142. (C) Internally, within the prothoracic tracheal tubes
The tracheal mite, Acarapis woodi, is an internal parasite that completes its entire life cycle within the prothoracic tracheae of adult honey bees. The mites enter the breathing tubes, where they feed on the bee's hemolymph and lay their eggs. A heavy infestation can obstruct the airflow, damage the wing muscles, and weaken the bee, eventually leading to the death of the individual and the colony.

143. (D) Using a screened bottom board with a sticky board
A screened bottom board is a simple and effective physical tool for monitoring and reducing Varroa mite populations. Mites that naturally fall off the bees drop through the mesh screen and onto a sticky board placed below, which prevents them from re-entering the hive. By counting the mites on the sticky board, beekeepers can accurately assess the infestation level and decide when treatment is necessary.

144. (C) Formic acid
Formic acid is a naturally occurring organic acid that is widely used as a fumigant for controlling both Varroa and tracheal mites. One of its unique advantages is its ability to penetrate the wax cappings and kill the mites that are reproducing inside the brood cells. When used correctly, it is highly effective and leaves no harmful synthetic residues in the honey or the beeswax.

145. (A) Both A and R are true and R is the correct explanation of A.
Tropilaelaps clareae is a highly specialized parasite that lacks the anatomical adaptations needed to feed on adult honey bees. Their mouthparts are unable to pierce the adult bee's tough exoskeleton to reach the hemolymph. Therefore, if a colony becomes broodless for even a short period, the mites will quickly die of starvation, which is a key biological weakness of this particular pest.

146. (D) Feeds on adult bees in a phoretic phase between cycles
A critical biological difference between these two parasitic mites is that Varroa destructor has a "phoretic" phase. During this stage, the adult female mites attach themselves to adult bees and feed on their fat body tissues. This phase allows the mites to survive even when no brood is present in the hive and provides a means for them to disperse to other honey bee colonies.

147. (A) Galleria mellonella
Galleria mellonella is the scientific name for the greater wax moth. It is a worldwide pest of honey bee colonies, particularly those that are weak or poorly managed. The adult moths enter the hive at night to lay their eggs on the combs. The resulting larvae then cause extensive damage as they feed on the beeswax, pollen, and larval remains, eventually destroying the structural integrity.

148. (C) Larvae tunneling wax combs leaving silken galleries
The primary damage caused by the greater wax moth is the result of the larval feeding behavior. As the larvae consume the beeswax and other hive resources, they tunnel through the middle of the comb, creating a network of silken galleries. These tunnels protect the larvae from the bees and eventually lead to the complete destruction of the comb, leaving behind a mass of silk and debris.

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149. (A) Vespa velutina
Vespa velutina, often called the yellow-legged wasp or Asian hornet, is a significant predator of honey bees. These wasps are known for "hawking" at the hive entrance, where they hover and wait to capture returning foragers in mid-air. Once a bee is caught, the wasp carries it away to consume the protein-rich thorax, which can lead to a devastating reduction in the colony's foraging force.

150. (D) Paradichlorobenzene (PDB)
Paradichlorobenzene is a common chemical fumigant used to protect stored honeycombs

from wax moth damage. When placed in stacks of empty combs, the PDB crystals sublimate into a heavy gas that kills all stages of the wax moth. However, because PDB can be absorbed by the wax and contaminate future honey crops, beekeepers must ensure the combs are thoroughly aired out before they are returned to the bees.

151. (B) Inverted cone traps baited with sweet liquid or meat
Mechanical traps are a safe and effective way to reduce the pressure of predatory wasps in an apiary. These traps often use an inverted cone design and are baited with fermented fruit juice, sugar syrup, or protein sources like meat. The wasps enter the trap through the bottom but are unable to find their way back out, helping to lower their population without using harmful insecticides.

152. (D) P-2, Q-4, R-1, S-3
The death's-head hawkmoth enters hives to consume honey, while the wax moth larva destroys the structure of the combs. The bee louse is a wingless fly that lives on the bodies of bees and steals food during trophallaxis. Predatory wasps decimate the workforce by preying on foragers at the hive entrance. Each of these pests requires specific management strategies to minimize their impact.

153. (D) Green Bee-eater (Merops orientalis)
The Green Bee-eater is a specialized avian predator that feeds almost exclusively on flying insects, with honey bees being a major part of its diet. These birds are often seen perched on wires or branches near apiaries, from which they sally out to capture bees on the wing. While they are beautiful birds, they can cause significant losses to honey bee populations during certain seasons.

154. (A) Smashing hives to eat brood, honey, and bees
In forested and mountainous regions, bears are a formidable threat to apiaries. They are attracted to the high-energy resources within the hive and will use their great strength to smash and tear apart the wooden boxes. Once the hive is open, the bear consumes the brood, honey, and even the adult bees themselves. Protecting apiaries from bears often requires the use of strong electric fencing.

155. (B) Elevating hives on stands with legs in water or oil
Ants can be a persistent nuisance in the apiary, stealing honey and attacking the brood. The most practical and non-chemical management strategy is to place the hive on a stand with legs that are submerged in "ant wells" filled with water or oil. This creates a physical barrier that the ants cannot cross, effectively protecting the colony from infestation without the need for harmful pesticides.

156. (B) Winter; for warm shelter and to feed on pollen
During the winter, rodents like mice may seek out bee hives as a source of warmth and protection from the elements. Once inside, they can cause significant damage by chewing on the wax combs and wooden frames. Additionally, they often feed on the stored pollen and honey, which can deplete the colony's essential winter food reserves and lead to the death of the bees.

157. (A) Sitting under boards at dusk to snap up returning foragers
Toads and frogs are opportunistic predators that can be found in the vicinity of bee hives, especially during damp weather. They often position themselves near the hive entrance or under the alighting board, where they use their long, sticky tongues to snap up returning foragers as they land. While they are not a major threat to the entire colony, they can contribute to worker loss.

158. (C) Neonicotinoids (e.g., Imidacloprid)
Neonicotinoids are a class of systemic insecticides that are highly toxic to honey bees. These chemicals can be absorbed by the plant and expressed in the pollen and nectar, where they are ingested by foragers. Even at sub-lethal doses, neonicotinoids can impair a bee's navigation, learning, and immune system, making them a major factor in the global decline of various pollinator species.

159. (C) I, III and IV
To protect honey bees from pesticide toxicity, farmers should use emulsifiable concentrates instead of microencapsulated formulations, which can be mistaken for pollen. Notifying beekeepers before chemical application and spraying during the evening or night when bees are not foraging are also critical safety measures. These strategies

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help minimize the direct exposure of pollinators to hazardous chemicals in the surrounding agricultural environment.

160. (C) Late evening or night, after foraging has ceased

The safest time to apply agricultural pesticides is during the late evening or at night. At this time, honey bees have returned to their hives and are no longer foraging on the crop. This allows the pesticide to dry or for its initial toxicity to decrease before the bees resume their activity the following morning, significantly reducing the risk of mass bee mortality.

****

NODIA

Nosema microsporidian parasites. However, the second statement is incorrect because Sacbrood virus primarily affects the larval stage of the honey bee rather than causing wing deformities in adult foragers.

132. (C) Septicemia
Septicemia is a bacterial infection of the honey bee's hemolymph, typically caused by Pseudomonas apiseptica. While it can cause adult bee mortality, it is not a viral disease. Chronic Bee Paralysis Virus, Thai Sacbrood Virus, and Kashmir Bee Virus are all recognized viral pathogens that can significantly impact the health and productivity of honey bee colonies, often leading to rapid population declines if left unmanaged.

133. (A) Oxytetracycline (Terramycin)
Oxytetracycline, often sold under the trade name Terramycin, has historically been used in many regions to treat and prevent outbreaks of European Foulbrood. It works by inhibiting the growth of the bacterium Melissococcus plutonius within the larval gut. However, its use is increasingly regulated to prevent the development of antibiotic resistance and to ensure that no residues remain in the honey produced for human consumption.

134. (D) Epithelial cells of the ventriculus
Nosema apis is a microsporidian parasite that targets the digestive system of adult honey bees. The spores are ingested by the bee and germinate in the midgut, or ventriculus. The parasite then invades and multiplies within the epithelial cells that line the gut wall. This infection disrupts the bee's ability to digest food and absorb nutrients, leading to malnutrition, weakness, and a significantly shortened lifespan.

135. (B) Ascosphaera apis
Chalkbrood is a fungal disease caused by the pathogen Ascosphaera apis. The fungus infects the larvae after they ingest the spores. As the fungus grows, it consumes the larval tissues, eventually filling the entire cell with a white, fluffy mycelium. The dead larvae then dry out into hard, chalk-like mummies that may be white or black, which the workers eventually remove from the hive.

136. (C) Aspergillus fumigatus / A. flavus
Stonebrood is caused by fungal species in the genus Aspergillus. Unlike chalkbrood, stonebrood mummies are extremely hard and difficult to crush. These fungi are also opportunistic pathogens that can cause respiratory issues, such as aspergillosis, in humans who are exposed to high concentrations of spores while handling infected combs. Beekeepers should use caution and proper protective equipment when dealing with colonies showing these symptoms.

137. (D) Excessive fecal spotting on the hive and top bars
A classic symptom of a severe Nosema infection is the presence of dysentery, which manifests as excessive fecal spotting on the exterior and interior surfaces of the hive. Because the parasite severely disrupts the bee's digestive tract, the infected individuals are unable to hold their waste until a cleansing flight. This fecal material also serves as a primary source of further spore transmission.

138. (B) III only
Nosema ceranae is a highly virulent parasite, and Acarapis woodi lives within the tracheae. Infection significantly reduces worker lifespan. However, the third statement is incorrect because Nosema spores are primarily transmitted through the ingestion of contaminated water or food, and during the cleaning of fecal-spotted combs by workers, rather than through the exchange of royal jelly between the nurse bees and the queen.

139. (B) Fumagillin
Fumagillin is a specialized antibiotic derived from the fungus Aspergillus fumigatus and is the only widely recognized pharmaceutical treatment for controlling Nosemosis. When administered in sugar syrup, it inhibits the replication of the Nosema parasite within the gut cells of the adult bees. Proper use of fumagillin, especially during the autumn or spring, can help colonies survive and recover from heavy parasite loads.

140. (B) Apis cerana
The parasitic mite Varroa destructor originally co-evolved with the eastern honey bee, Apis cerana. In its natural host, the mite's impact is limited by the bee's grooming behavior and its tendency to only reproduce in drone brood. However, when the mite jumped to the western honey bee, Apis mellifera, it found a host with

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as Asan and serves as a primary host for tasar silkworms.
III. Castor is the primary host for muga silkworms in Assam.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I

2007

11. What is the fundamental ecological consequence of the monophagous nature of Bombyx mori?
(A) It necessitates the synchronized cultivation of Morus species.
(B) It limits sericulture production activities entirely to tropical climatic zones.
(C) It allows the silkworm to easily switch to alternative wild plants during mulberry scarcity.
(D) It prevents the silkworm from acquiring resistance to any specific viral pathogens.

2008

12. Which of the following is an INCORRECT pair of a non-mulberry silkworm and its secondary host plant?
(A) Eri silkworm - Tapioca (Manihot esculenta)
(B) Tasar silkworm - Sal (Shorea robusta)
(C) Muga silkworm - Castor (Ricinus communis)
(D) Temperate Tasar - Quercus himalayana

2018

13. The morphological presence of a distinctive caudal horn is a characteristic feature found on the dorsal surface of which abdominal segment in Bombyx mori larvae?
(A) Fifth abdominal segment
(B) Sixth abdominal segment
(C) Tenth abdominal segment
(D) Eighth abdominal segment

2015

14. How many pairs of spiracles are anatomically present in a fully grown Bombyx mori larva?
(A) 7 pairs
(B) 11 pairs
(C) 9 pairs
(D) 13 pairs

2008

15. Given below are two statements, one labeled as Assertion (A) and the other labeled as Reason (R).
Assertion (A): The adult female Bombyx mori moth cannot fly despite having fully developed wings.
Reason (R): Domestication over centuries has increased its body weight and reduced its wing muscle functional capacity.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2018

16. During the life cycle of Bombyx mori, which structural adaptation allows the larva to firmly grip the rearing bed or leaf surface?
(A) Mandibles
(B) Setae on the thoracic segments
(C) Maxillary palps
(D) Crochets on the prolegs

2019

17. The transition from the pupal stage to the adult moth in silkworms requires the secretion of a specialized fluid to soften the cocoon. Which gland produces this fluid?
(A) Maxillary gland
(B) Silk gland
(C) Prothoracic gland
(D) Corpora allata

2001

18. Which statement INCORRECTLY describes the egg stage of a bivoltine Bombyx mori?
(A) Diapausing eggs are typically dark brown or purplish in appearance.
(B) Non-diapausing eggs remain light yellow until the completion of hatching.
(C) The chorion is completely impermeable to oxygen.
(D) The micropyle allows for the entry of sperm during the process of fertilization.

2019

19. What is the most relevant physiological function of the spinneret in a mature silkworm larva?
(A) It extrudes liquid silk which solidifies upon contact with air.
(B) It digests complex carbohydrates in the midgut.
(C) It regulates the release of juvenile hormone during moulting.
(D) It filters out harmful microbes from ingested mulberry leaves.

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CHAPTER 16
Silkworms and Sericulture

2009

1. Which of the following silkworm species correctly belongs to the family Saturniidae?
(A) Antheraea assamensis
(B) Bombyx mori
(C) Bombyx mandarina
(D) Rondotia menciana

2021

2. What is the primary geographical origin and distribution center of the commercially exploited mulberry silkworm, Bombyx mori?
(A) Brahmaputra Valley, India
(B) Kyoto, Japan
(C) Central China
(D) Western Europe

2011

3. In the classification of silkworms, which statement correctly differentiates Bombycidae from Saturniidae?
(A) Bombycidae are fully domesticated, while commercial Saturniidae remain wild.
(B) Bombycidae pupate in soil, whereas Saturniidae pupate exclusively inside leaves.
(C) Bombycidae produce colored silk naturally, while all Saturniidae produce pure white silk.
(D) Bombycidae larvae lack true legs, while Saturniidae larvae possess them during the stage.

2016

4. Identify the INCORRECT statement regarding the taxonomy of the muga silkworm.
(A) It belongs to the order Lepidoptera.
(B) Its scientific name is Antheraea assamensis.
(C) It is an endemic species geographically restricted to Northeast India.
(D) It is strictly monophagous, feeding only on castor leaves.

2012

5. The application of systematic taxonomy in sericulture is most relevant for which of the following?
(A) Determining the optimal market price for finished silk fabric in the textile industry.
(B) Identifying compatible parent species for interspecific hybridization.
(C) Designing automated rearing trays for grainage operations and egg production.
(D) Regulating the humidity levels inside a rearing house during the larval stages.

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2010

6. The tasar silkworm (Antheraea mylitta) is predominantly distributed across which geographical region in India?
(A) The alpine Himalayan regions of Kashmir
(B) The coastal mangrove forests of Bengal
(C) The central and eastern tropical forest belt
(D) The arid desert regions of Rajasthan

2003

7. Which pair correctly matches the silkworm species with its primary host plant?
(A) Eri silkworm - Machilus bombycina
(B) Muga silkworm - Terminalia arjuna
(C) Tasar silkworm - Morus alba
(D) Eri silkworm - Ricinus communis

2007

8. The host plant Som (Machilus bombycina) is primarily classified as the food source for which silkworm?
(A) Antheraea assamensis
(B) Bombyx mori
(C) Antheraea mylitta
(D) Samia cynthia ricini

2014

9. Which of the following represents the most appropriate secondary host plant for the tropical tasar silkworm (Antheraea mylitta)?
(A) Litsaea polyantha (Soalu)
(B) Ziziphus mauritiana (Ber)
(C) Ricinus communis (Castor)
(D) Quercus serrata (Oak)

2013

10. Consider the following statements regarding host plants of silkworms:
I. Mulberry (Morus spp.) is the exclusive primary food source for Bombyx mori.
II. Terminalia tomentosa is commonly known

2017

29. Which specific secondary metabolite in mulberry leaves acts as the primary biting factor (phagostimulant) for Bombyx mori larvae?
(A) Citral
(B) Quercetin
(C) Phytol
(D) Morin

2007

30. Consider the following statements regarding the artificial diet formulations for silkworms:
I. Agar-agar is commonly used as a gelling agent.
II. Defatted soybean meal provides the bulk of the protein requirement.
III. Cellulose powder acts as a digestible energy source.
IV. Ascorbic acid is strictly avoided as it inhibits larval growth.
V. Sorbic acid is added as an antimicrobial agent.
Which of the above statement(s) is/are INCORRECT?
(A) I, II and V
(B) III and IV
(C) II, III and IV
(D) I, III, IV and V

2019

31. During which larval stage does the silkworm consume approximately 80-85% of its total lifetime food intake?
(A) First instar
(B) Fifth instar
(C) Second instar
(D) Fourth instar

2018

32. Which nutrient deficiency in the silkworm diet leads to incomplete moulting and severe physical deformities?
(A) Vitamin C (Ascorbic Acid)
(B) Sucrose (Table Sugar)
(C) Potassium (Essential Minerals)
(D) Sterols (e.g., β-sitosterol)

2022

33. The feeding behavior of young age (chawki) silkworms differs from late age larvae primarily in that chawki worms:
(A) Prefer tender leaves with high moisture and high protein content.
(B) Require highly mature, coarse leaves with low moisture content.
(C) Depend exclusively on olfactory cues rather than gustatory cues.
(D) Feed optimally only in complete darkness.

2007

34. What is the most significant physiological advantage of providing ascorbic acid in the silkworm diet?
(A) It hardens the larval exoskeleton prematurely during the growth stage.
(B) It promotes robust larval growth.
(C) It substitutes the fundamental requirement for sufficient dietary water.
(D) It directly alters the genetic voltism expressed by the silkworm strain.

2004

35. In an artificial diet formulation, what role does sitosterol play for the silkworm?
(A) It serves as a precursor for the synthesis of ecdysone.
(B) It functions as a direct phagorepellent.
(C) It acts as a primary source of carbohydrates.
(D) It regulates the water balance in the hindgut.

2014

36. Which environmental factor perceived during the embryonic development (egg incubation) most significantly dictates the voltism of the subsequent generation in bivoltine silkworms?
(A) Atmospheric pressure
(B) Soil moisture levels
(C) Mulberry leaf quality
(D) Photoperiod and temperature

2002

37. The diapause hormone (DH), which arrests embryonic development to overcome adverse environmental conditions, is secreted by which structure in the female moth?
(A) Corpora allata
(B) Suboesophageal ganglion
(C) Prothoracic gland
(D) Brain neurosecretory cells

2011

38. A silkworm strain that inherently completes only one life cycle per year regardless of favorable environmental conditions is strictly termed:
(A) Obligate bivoltine
(B) Facultative multivoltine
(C) Obligate univoltine
(D) Facultative univoltine

2009

39. Which biological principle explains why polyvoltine silkworm strains naturally

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2016

20. Consider the following statements about the anatomy of the Bombyx mori larva:

I. The head is formed by the fusion of six embryonic segments.

II. The thorax consists of three segments, each bearing a pair of true legs.

III. The abdomen consists of eleven segments in the adult larval stage.

IV. The silk gland is an exocrine gland divided into three distinct regions.

Which of the above statement(s) is/are correct?

(A) I, II and IV

(B) II, III and IV

(C) I and IV

(D) I, II and III

2003

21. Morphologically, how can one distinguish a female silkworm pupa from a male pupa?

(A) The female pupa is smaller and possesses a prominent Herold's gland at the posterior end.

(B) The female pupa is larger and features an X-shaped mark.

(C) The male pupa is significantly wider and lacks distinct abdominal segmentation in the final stage.

(D) The female pupa has longer antennae that are clearly visible through the outer pupal case.

2001

22. In the anatomy of the silkworm, which part of the silk gland is primarily responsible for the synthesis of the protein fibroin?

(A) Anterior region

(B) Middle region

(C) Posterior region

(D) Filippi's gland

2003

23. Biochemically, what is the approximate percentage of sericin in a typical B. mori silk bave?

(A) 5-10%

(B) 45-50%

(C) 70-75%

(D) 20-25%

2003

24. Which phenomenon occurs if the middle portion of the silk gland fails to produce sufficient sericin?

(A) The fibroin filaments will not adhere together.

(B) The pupation period will be completely halted for the affected larvae.

(C) The resultant silk will be excessively rigid and brittle after harvesting.

(D) The larva will immediately excrete the fibroin through its digestive tract.

NODIA

2009

25. Match the items in List I with the descriptions in List II.

List I: (Biochemical components and anatomical structures)

P. Fibroin

Q. Sericin

R. Filippi's gland

S. Anterior silk gland

List II: (Descriptions)

1. Secretes a viscous substance to lubricate the silk thread
2. Acts primarily as a structural core protein
3. Serves as a duct to transport liquid silk to the spinneret
4. Acts as a water-soluble gummy coating

(A) P-2, Q-4, R-1, S-3

(B) P-4, Q-2, R-3, S-1

(C) P-1, Q-4, R-2, S-3

(D) P-2, Q-1, R-4, S-3

2024

26. Which amino acid is most abundantly present in the composition of silk fibroin?

(A) Tryptophan

(B) Glycine

(C) Methionine

(D) Histidine

2003

27. The physiological transport of nutrients to the silk gland during the fifth instar is primarily facilitated by which fluid?

(A) Haemolymph

(B) Saliva

(C) Gastric juice

(D) Exuvial fluid

2022

28. How does the degradation of dietary proteins in the midgut directly influence silk production?

(A) It reduces the metabolic heat required for spinning silk during the fifth instar.

(B) It triggers the pupal diapause mechanism within the developing silkworm eggs.

(C) It provides the amino acids for protein synthesis.

(D) It inhibits the secretion of sericin in the middle portion of the silk gland.

2003

49. The chemical compound 'Precocene' functions in sericulture research as an:
(A) Anti-Juvenile Hormone agent
(B) Ecdysone agonist
(C) Synthetic diapause hormone
(D) Artificial phagostimulant

2014

50. Arrange the following indigenous and exotic silkworm breeds in order from lowest average cocoon shell ratio to highest average cocoon shell ratio:
I. Pure Mysore (Multivoltine)
II. CSR2 (Highly productive Bivoltine)
III. Nistari (Indigenous Multivoltine)
IV. NB4D2 (Standard Bivoltine)
(A) I, III, IV, II
(B) III, I, IV, II
(C) III, I, II, IV
(D) I, IV, III, II

2007

51. The indigenous silkworm breed 'Pure Mysore' is characterized by which of the following traits?
(A) Greenish-yellow pointed cocoons and multivoltine nature
(B) White spindle-shaped cocoons and bivoltine nature
(C) Pure white oval cocoons and univoltine nature
(D) Golden yellow spherical cocoons and diapause-dependent hatching

2009

52. What is the primary objective of crossing a multivoltine female with a bivoltine male to produce Multi x Bi hybrids in India?
(A) To generate completely sterile offspring for disease control in commercial farms.
(B) To produce larvae that can feed exclusively on alternate host plants in the wild.
(C) To eliminate the need for any rearing house environmental control during the summer.
(D) To combine disease resistance with silk yield.

2004

53. Which of the following is considered an exotic bivoltine silkworm breed widely utilized in Indian hybridization programs?
(A) Moria
(B) Shungetsu x Hosho
(C) Nistari
(D) Sarupat

2018

54. Identify the INCORRECT statement regarding the classification of silkworm breeds.
(A) Japanese breeds typically produce peanut-shaped cocoons.
(B) Chinese breeds are characterized by oval or spherical cocoons.
(C) European breeds are usually multivoltine with very short larval spans.
(D) Indian indigenous breeds generally show high tolerance to fluctuating temperatures.

2016

55. Match the silkworm breed characteristics in List I with the classifications in List II.
List I: (Breed Characteristics)
P. Long larval duration, very large cocoons, univoltine
Q. High survival rate, small greenish/yellow cocoons, multivoltine
R. Peanut-shaped cocoons, distinct larval markings
S. Developed by CSRTI Mysore for tropical high-yield
List II: (Classifications)
1. Pure Mysore
2. CSR Hybrids
3. European Breeds
4. Japanese Breeds
(A) P-3, Q-1, R-4, S-2
(B) P-1, Q-2, R-3, S-4
(C) P-4, Q-3, R-1, S-2
(D) P-3, Q-4, R-2, S-1

2011

56. What genetic phenomenon is principally exploited when F1 hybrids are used commercially in sericulture?
(A) Heterosis (Hybrid vigor)
(B) Mutation breeding
(C) Polyploidy
(D) Epistasis

2022

57. In tropical regions, what is the most appropriate orientation for a silkworm rearing house to minimize direct solar heat gain?
(A) North-South direction (longer axis running North-South)
(B) East-West direction (longer axis running East-West)
(C) Northeast-Southwest diagonal
(D) Circular orientation with a central dome

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2013

132. The application of "Uzicide" on the body of silkworm larvae is designed to:
(A) Heal the black scars left by maggots upon their entry into the body.
(B) Boost the silk gland size to compensate for damage caused by parasites.
(C) Poison the adult Uzi fly upon contact with the treated silkworm body.
(D) Prevent Uzi fly egg hatching.

2001

133. During which specific stage of the Uzi fly's life cycle does it generally reside in the dark corners, crevices, and loose soil of the rearing house?
(A) Egg stage
(B) Pupal stage
(C) Actively feeding maggot stage
(D) Adult mating stage

2021

134. Dermestid beetles (Dermestes maculatus) are major secondary pests in sericulture. They primarily inflict economic damage by:
(A) Eating the fresh mulberry leaves on the rearing bed during the fifth instar.
(B) Laying eggs inside the spinning caterpillars while they are on the mountage.
(C) Boring into cocoons and cutting filaments.
(D) Carrying Pebrine spores from one grainage to another through direct contact.

2009

135. Given below are two statements, one labeled as Assertion (A) and the other labeled as Reason (R).
Assertion (A): Proper storage of pierced cocoons in a separate, completely enclosed building is strictly advised.
Reason (R): Dermestid beetles multiply rapidly in pierced cocoons and their migrating larvae can easily bore into and destroy fresh, reelable seed cocoons if stored nearby.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2011

136. Ants frequently attack early instars (chawki worms) in the rearing house. Which of the following is the most standard preventive measure?
(A) Using ant wells on rearing stands.
(B) Dusting pure bleaching powder directly onto the worms and the mulberry leaf.
(C) Keeping a cat inside the rearing house to deter small pests and rodents.
(D) Lowering the room temperature to 15°C to slow down the insect activity.

2025

137. Which vertebrate predator is known to cause significant damage to the silkworm crop during outdoor rearing of non-mulberry species like Tasar and Muga?
(A) Monitor lizards
(B) Insectivorous birds and bats
(C) Domestic cattle
(D) Herbivorous rodents

2022

138. In a grainage, mites of the genus Pyemotes can become a severe pest. What specific damage do they cause?
(A) They consume the stored silk yarn within the warehouse storage facilities.
(B) They suck hemolymph from adult moths.
(C) They bore microscopic holes into the rearing trays used for chawki larvae.
(D) They feed on the wax layer of the mulberry leaf in the local plantations.

NODIA

2017

139. Which method is most effective for breaking the life cycle of the Dermestid beetle in a cocoon storage facility?
(A) Periodic fumigation and disposal.
(B) Spraying water on the stored cocoons weekly to maintain high humidity.
(C) Increasing the room humidity to 90% to drown the larvae of the beetles.
(D) Exposing the cocoons to intense UV light during the night for sterilization.

2019

140. Apart from biological and chemical controls, what mechanical method is commonly used to trap adult Uzi flies inside a rearing room?
(A) Light traps equipped with high-voltage grids to kill all flying insects.
(B) Large vacuum exhaust fans installed in the roof of the rearing house.
(C) Using sticky traps or water pans.
(D) Ultrasonic sound emitters that disrupt the mating behavior of the fly.

(C) Placed over the windows to block flying insects
(D) Inside the rearing trays alongside the mulberry leaves

2010

68. Which appliance is specifically designed to facilitate the uniform chopping of mulberry leaves for early instar larvae?
(A) Rotary mountage
(B) Hygrometer
(C) Wet-bulb thermometer
(D) Leaf chopping block and knife

2016

69. A rotary mountage is considered superior to a traditional bamboo mountage (Chandrike) primarily because:
(A) It automatically regulates the room temperature to ideal levels.
(B) It ensures uniform spinning.
(C) It forces the worms to spin colorful cocoons through dietary changes.
(D) It eliminates the need for any chemical disinfectants in the room.

2011

70. Consider the following statements regarding silkworm rearing appliances:
I. Paraffin paper is used to cover chawki rearing beds to retain moisture.
II. Feather brushes are used to gently brush newly hatched larvae.
III. Mountages must be completely airtight to ensure spherical cocoons.
IV. Wooden or bamboo rearing trays hold the leaf and the growing larvae.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, III and IV
(C) II and III
(D) I, II, III and IV

2018

71. Chawki rearing refers to the specialized management of which developmental stages of the silkworm?
(A) The spinning stage and pupation
(B) The fourth and fifth larval instars
(C) The egg incubation and hatching phase
(D) The first and second larval instars

2007

72. What is the optimal temperature range typically recommended for successful chawki rearing?
(A) 27°C - 28°C
(B) 20°C - 22°C
(C) 32°C - 35°C
(D) 15°C - 18°C

2005

73. The concept of Chawki Rearing Centers (CRCs) was established to resolve which major issue in sericulture?
(A) The high cost of marketing finished silk garments in the global textile market.
(B) The poor survival rate of young larvae.
(C) The overproduction of over-matured mulberry leaves in the local plantations.
(D) The inability of farmers to harvest cocoons manually without damaging the silk.

2002

74. Which specific feeding strategy is recommended during chawki rearing to ensure robust growth?
(A) Feeding only whole, unchopped mature leaves once a day
(B) Feeding finely chopped tender succulent leaves at frequent intervals
(C) Feeding coarsely chopped bottom leaves twice a week
(D) Starving the larvae for 24 hours after hatching to clear their gut

2023

75. Given below are two statements, one labeled as Assertion (A) and the other labeled as Reason (R).
Assertion (A): Maintaining high relative humidity (85-90%) in the chawki rearing bed is crucial.
Reason (R): High humidity prevents the rapid withering of chopped tender leaves, ensuring continuous feeding by the delicate young larvae.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2007

76. During chawki rearing, the "black boxing" technique is employed just before the expected hatching date. What is its main purpose?
(A) To induce random and prolonged hatching over a week for experimental purposes.
(B) To kill any pathogenic fungi present on the chorion during the incubation.
(C) To ensure synchronized hatching.
(D) To prematurely terminate embryonic

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2003

58. Which of the following environmental parameters is strictly maintained at a higher level during chawki rearing compared to late-age rearing?
(A) Light intensity
(B) Relative Humidity
(C) Wind velocity
(D) Carbon dioxide concentration

2022

59. The provision of cross-ventilation in a rearing house is most critical during the fifth instar. What is the primary reason for this?
(A) To dissipate metabolic heat.
(B) To ensure a steady supply of nitrogen for fibroin synthesis in the silk glands.
(C) To allow natural predators to enter and balance the ecosystem of the room.
(D) To dry the mulberry leaves completely before consumption by the mature larvae.

2005

60. Consider the following statements regarding rearing house design:
I. The roof should ideally be made of materials with low thermal conductivity.
II. A verandah all around helps in buffering extreme external temperatures.
III. Floor-to-ceiling windows on all sides are mandatory for maintaining complete darkness.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I

2005

61. What is the functional purpose of installing a rat-proof mesh or trench around the foundation of a silkworm rearing house?
(A) To prevent the entry of Uzi flies through the windows.
(B) To act as a drainage system for excess disinfectants and water.
(C) To trap escaping silkworm moths during the grainage process.
(D) To protect from vertebrate predators.

2005

62. In a well-designed rearing house, the recommended height of the side walls is generally kept between 10 to 12 feet. What does this specific height optimize?
(A) It prevents the growth of fungal spores on the ceiling.
(B) It ensures the UV light from the sun sanitizes the floor.
(C) It provides adequate air volume per unit of rearing space.
(D) It limits the vertical flight of the adult moths.

2018

63. Which type of roof material is least suitable for a silkworm rearing house in a hot tropical climate unless a false ceiling is provided?
(A) Thatch
(B) Asbestos or galvanized iron sheets
(C) Mangalore tiles
(D) Reinforced concrete cement (RCC)

2008

64. What is the specific function of a 'Chandrike' in sericulture?
(A) It is used to incubate silkworm eggs.
(B) It is a net used to separate uneaten leaves from the rearing bed.
(C) It is a device to monitor room humidity.
(D) It serves as a support structure for larvae to spin their cocoons.

2013

65. Foam pads are commonly utilized during the rearing of chawki worms. What is their primary application?
(A) To prevent leaf drying.
(B) To absorb toxic ammonia gas from the rearing bed during the larval stages.
(C) To provide a soft resting surface to prevent larval injury during feeding.
(D) To physically crush Uzi fly eggs deposited on the body of the silkworm.

2003

66. During bed cleaning operations, cleaning nets of various mesh sizes are used. Which principle dictates the choice of the net?
(A) The mesh size should strictly be smaller than the head capsule of the larva.
(B) The mesh size must trap the larvae to easily transfer them to a waste bin.
(C) The mesh size separates larvae from waste.
(D) The mesh must be completely impermeable to air to maintain high humidity.

2018

67. Ant wells are essential rearing appliances. Where are they typically positioned?
(A) Under the legs of the rearing stands
(B) Hanging from the ceiling above the rearing stands

NODIA

1. Reared indoors similarly to mulberry silkworms
2. Reared exclusively outdoors on Som and Soalu trees in Assam
3. Reared outdoors in tropical forests on Asan and Arjun trees
4. Reared on Quercus species in sub-Himalayan belts

(A) P-3, Q-1, R-2, S-4
(B) P-2, Q-4, R-1, S-3
(C) P-3, Q-2, R-1, S-4
(D) P-1, Q-3, R-4, S-2

2016

86. Which distinct behavioral trait of the Eri silkworm makes it uniquely suitable for complete indoor rearing among the non-mulberry species?
(A) Its larvae possess an aggressive stinging mechanism for defense.
(B) Its larvae burrow into the soil to pupate during the winter.
(C) Its larvae lack the strong wandering instinct.
(D) Its larvae can synthesize their own food through specialized symbionts.

2013

87. In outdoor muga silkworm rearing, what is the purpose of tying a 'Chaloni' (a protective band of banana pseudo-stem or dry leaves) around the tree trunk?
(A) To prevent the host tree from absorbing excess water during the monsoon season.
(B) To act as a reservoir for chemical fertilizers applied to the root system.
(C) To trap predatory birds that attempt to feed on the silkworms in the canopy.
(D) To facilitate collection for mounting.

2011

88. What represents the highest risk factor contributing to larval mortality during the outdoor rearing of tropical tasar silkworms?
(A) Attack by natural predators.
(B) Prolonged exposure to indoor fluorescent lighting in the rearing room.
(C) Depletion of oxygen at high altitudes in the sub-Himalayan region.
(D) Lack of artificial diet supplements provided during the early larval instars.

2022

89. The 'Chawki' stage of tasar silkworms is often managed under a semi-enclosed structure covered with nylon nets before being transferred to open trees. What is this practice called?
(A) Controlled indoor brushing
(B) Chawki garden rearing / Nylon net rearing
(C) Floor bed incubation
(D) Sub-surface grainage

2002

90. Select the correct sequence of operations in the outdoor rearing of muga silkworms.
(A) Brushing on trees → Transfer of worms to fresh trees → Collection of ripe worms → Mounting
(B) Mounting → Transfer of worms → Brushing on trees → Collection of ripe worms
(C) Collection of ripe worms → Brushing on trees → Mounting → Transfer of worms
(D) Brushing on trees → Mounting → Collection of ripe worms → Transfer of worms

2021

91. The cocoon of the Eri silkworm is unique among commercial silks because:
(A) The thread is discontinuous.
(B) It is composed purely of sericin with no fibroin in the core filament.
(C) It dissolves completely in hot water during the standard boiling process.
(D) It naturally exhibits a bright blue coloration due to its chemical pigment.

NODIA

2016

92. In sericulture terminology, what does "Grainage" refer to?
(A) The market where raw silk is auctioned to various weavers and traders.
(B) The facility where cocoons are boiled and reeled into continuous silk yarn.
(C) The production of disease-free layings.
(D) The warehouse for storing excess mulberry leaves collected from the fields.

2015

93. What is the primary objective of "mother moth examination" during grainage operations?
(A) To evaluate the wingspan of the female moth for selection of strong flyers.
(B) To select moths that will produce multi-colored silk for specialized weaving.
(C) To extract the diapause hormone for commercial sale in the hormone industry.
(D) To microscopically detect pebrine spores.

2019

94. During the pairing process in grainage, what is the standard recommended duration of mating to ensure optimum fertilization of eggs?
(A) 30 to 45 minutes

(D) Pebrine

2018

114. The classic diagnostic symptom of Grasserie disease in advanced stages is:
(A) The larva shrinking in size and becoming woody hard due to internal calcification.
(B) The body being completely covered in white powdery fungal spores after death.
(C) Swelling of intersegmental membranes.
(D) The appearance of distinct black pepper-like spots on the skin of the larva.

2006

115. Match the items in List I with the causative agents in List II.
List I: (Silkworm diseases)
P. Grasserie
Q. Flacherie
R. White Muscardine
S. Pebrine
List II: (Causative agents)
1. Bacillus thuringiensis / BmIFV
2. Nosema bombycis
3. Borrelina virus (BmNPV)
4. Beauveria bassiana
(A) P-3, Q-1, R-4, S-2
(B) P-2, Q-4, R-1, S-3
(C) P-4, Q-3, R-2, S-1
(D) P-1, Q-2, R-3, S-4

2017

116. Flacherie is broadly classified into viral and bacterial types. A common symptom of bacterial flacherie is:
(A) Transovarial transmission to the next generation through the egg stage.
(B) The larva mounting the chandrike perfectly but failing to spin the cocoon.
(C) Sudden calcification of the larval body within two hours of the infection.
(D) Excretion of soft, wet feces.

2017

117. What environmental condition primarily predisposes a late-age silkworm rearing batch to Flacherie?
(A) Exposure to extreme cold temperatures (below 10°C) during the larval stages.
(B) Poor climate and leaf quality.
(C) Rearing the silkworms in absolute darkness without any light stimulation.
(D) Over-application of chemical fertilizers to the soil in the mulberry fields.

2015

118. Which specific management practice is highly recommended for the immediate containment of a Grasserie outbreak in a rearing bed?
(A) Raising the room humidity to 95% to help the larvae shed their skin easily.
(B) Spraying the larvae directly with concentrated hydrochloric acid solutions.
(C) Systematic identification and removal of affected larvae from the rearing bed.
(D) Stopping the feeding of mulberry leaves completely for a period of 48 hours.

2011

119. A silkworm affected by infectious flacherie viral disease (BmIFV) shows empty foregut and midgut. This condition is colloquially referred to in sericulture as:
(A) Milky disease
(B) Chalky disease
(C) Pepper disease
(D) Clear head disease (Touming)

2017

120. Consider the following statements about White Muscardine disease:
I. It is caused by the fungus Beauveria bassiana.
II. It is most prevalent during hot and extremely dry weather conditions.
III. The infected dead larva hardens and mummifies, eventually becoming covered in white spores.
IV. Application of a fungicide-based bed disinfectant like Vijetha effectively prevents its spread.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, III and IV
(C) II, III and IV
(D) I and III

2018

121. The term "calcino" is historically used to describe the mummified state of larvae dead from which type of infection?
(A) Protozoan
(B) Fungal
(C) Viral
(D) Bacterial

2021

122. Pebrine is considered the most dreaded disease in sericulture primarily because of its mode of transmission. How is it distinctly transmitted?
(A) Only through the bite of the Uzi fly during the late larval stages.

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2008

104. Which vital parameter is carefully monitored during the "hibernation schedule" of silkworm eggs to ensure safe overwintering?
(A) Temperature lowering and high humidity.
(B) Ensuring continuous bright illumination throughout the entire storage period.
(C) Keeping the eggs completely submerged in distilled water to prevent drying.
(D) Subjecting eggs to daily fluctuations between 0°C and 30°C for hardening.

2015

105. Given below are two statements, one labeled as Assertion (A) and the other labeled as Reason (R).
Assertion (A): It is essential to wash the silkworm eggs thoroughly with running water immediately after HCl treatment.
Reason (R): Retained traces of acid can penetrate the micropyle and cause severe acid burns, leading to embryonic mortality.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2023

106. In the context of grainage economics, what does the abbreviation 'DFL' stand for?
(A) Daily Feeding Limit
(B) Disease Free Laying
(C) Diapause Frequency Level
(D) Direct Filament Length

2014

107. Which factor contributes most heavily to the variable costs in the production of DFLs in a commercial grainage?
(A) Cost of purchasing seed cocoons
(B) Depreciation on the grainage building
(C) Salary of the permanent managerial staff
(D) Cost of the microscope

2014

108. A standard Disease Free Laying (DFL) of a bivoltine hybrid contains approximately how many eggs?
(A) 100 - 150 eggs
(B) 250 - 300 eggs
(C) 450 - 550 eggs
(D) 800 - 1000 eggs

2009

109. What is the fundamental requirement for a grainage operation to maintain a favorable cost-benefit ratio?
(A) Maximizing the percentage of pupal mortality during the storage of cocoons.
(B) Optimizing moth emergence and pairing.
(C) Delaying the processing of seed cocoons until they dry completely for storage.
(D) Selling unfertilized eggs to commercial reelers at a subsidized market rate.

2021

110. Consider the following statements regarding the economics of seed production:
I. The recovery percentage of DFLs is calculated by dividing the total DFLs produced by the total number of seed cocoons processed.
II. A high pebrine incidence severely reduces the economic viability of a grainage.
III. Selling seed cocoons is always more profitable than selling DFLs.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) II

2019

111. Which operational inefficiency leads to the highest hidden economic loss in a silkworm seed production center?
(A) Using automated temperature control systems in the grainage room.
(B) Asynchronous moth emergence.
(C) Conducting mother moth examinations too rapidly to ensure disease control.
(D) Using reusable plastic egg cards instead of traditional paper ones for eggs.

2025

112. The "Recovery Rate" in a grainage is an important economic metric. In a highly efficient bivoltine grainage, 1 kg of seed cocoons yields roughly how many DFLs?
(A) 10 - 20 DFLs
(B) 60 - 70 DFLs
(C) 200 - 250 DFLs
(D) 500 - 600 DFLs

2024

113. Nuclear Polyhedrosis Virus (NPV) causes which devastating disease in the mulberry silkworm?
(A) Grasserie
(B) Flacherie
(C) Muscardine

NODIA

development through environmental stress.

2019

77. Brushing is a critical operation in early sericulture. What exactly does brushing involve?
(A) Cleaning the rearing room floor with a broom after the larval feeding is over.
(B) Removing the silk webbing from the harvested cocoons before they are sold.
(C) Applying chemical disinfectants directly onto the silkworm's body for disease.
(D) The technical transfer of newly hatched larvae from egg cards to rearing beds.

2006

78. In late-age silkworm rearing (4th and 5th instars), shoot rearing is highly preferred over tray rearing for large-scale operations. Which of the following is the most significant advantage of shoot rearing?
(A) It completely eradicates the risk of Uzi fly infestation in the rearing area.
(B) It ensures the production of exclusively univoltine eggs for next season.
(C) It reduces labor costs.
(D) It halves the total larval duration by increasing the rate of food intake.

2014

79. How does the required micro-climate for late-age rearing differ from that of chawki rearing?
(A) Late-age worms require significantly higher temperatures and higher humidity.
(B) Late-age worms require slightly lower temperatures and lower humidity with excellent ventilation.
(C) Late-age worms require complete darkness and zero air circulation.
(D) There is absolutely no difference in the climatic requirements between the stages.

2003

80. Consider the following statements regarding late-age floor rearing:
I. It is suitable for small-scale farmers with limited floor space.
II. Branches with leaves are directly fed to the larvae on raised platforms or the floor.
III. It facilitates better air circulation compared to stacked tray rearing.
IV. The incidence of secondary infections can increase if bed sanitation is neglected.
V. It completely eliminates the need for any mountages.
Which of the above statement(s) is/are INCORRECT?
(A) I and V
(B) II and III
(C) I, IV and V
(D) II, III and IV

2006

81. What is the recommended frequency of bed cleaning during the fifth instar in a typical tray rearing system?
(A) Daily
(B) Once every three days
(C) Only once right before spinning
(D) Never, as cleaning disturbs larval growth

2011

82. Which physiological indicator signals that a fifth instar larva has reached "ripening" and is ready to be transferred to a mountage?
(A) The larva becomes entirely black and moves around the tray with high activity.
(B) The larva begins to feed voraciously on the hardest leaves available in the tray.
(C) The body becomes translucent.
(D) The larva tightly curls into a ball and secretes a defensive odor to ward off pests.

2002

83. The process of picking ripe worms and transferring them to Chandrikes is technically referred to as:
(A) Mounting
(B) Brushing
(C) Stifling
(D) Decoupling

2015

84. Overcrowding of late-age larvae in the rearing bed typically results in all of the following EXCEPT:
(A) Unequal growth and size variation
(B) Increased susceptibility to diseases due to microclimate deterioration
(C) Accumulation of excessive moisture and heat
(D) Enhanced silk quality and uniform cocoon shape

2021

85. Match the species in List I with the characteristics in List II.
List I: (Silkworm species)
P. Tasar silkworm
Q. Eri silkworm
R. Muga silkworm
S. Oak Tasar silkworm
List II: (Rearing characteristics)

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(B) Horizontal and vertical transmission.
(C) Through contaminated air exclusively within the rearing house premises.
(D) Through direct skin contact with mulberry sap during the feeding process.

2004

123. The diagnostic observation of highly refractile, oval-shaped spores under phase-contrast microscopy of crushed moth tissues is confirmatory for which pathogen?
(A) Nosema bombycis
(B) Borrelina virus
(C) Bacillus cereus
(D) Aspergillus flavus

2002

124. Louis Pasteur made a monumental contribution to the global sericulture industry by developing a control method for which disease?
(A) Grasserie
(B) Flacherie
(C) Pebrine
(D) Uzi fly infestation

2003

125. In the context of Muscardine management, why is formalin chaff applied to the rearing bed?
(A) To provide an alternate food source for the larvae during scarcity periods.
(B) To increase the nutritional value of mulberry leaves through chemical enrichment.
(C) To induce the moulting process prematurely to avoid the spread of diseases.
(D) To act as a slow-release fumigant.

2002

126. What visible symptom on the integument characterizes the advanced stage of a Pebrine infection in silkworm larvae?
(A) Milky white fluid oozing from joints during the late larval stages.
(B) Large green patches on the dorsal side of the fifth instar silkworm.
(C) Black pepper-like spots on the body.
(D) Dense white fungal mycelia covering the entire surface of the larva.

2012

127. The Uzi fly (Exorista bombycis) poses a severe threat to sericulture. Taxonomically, it is classified as an:
(A) Ectoparasite
(B) Endoparasitoid
(C) Obligate predator
(D) Herbivorous pest

2009

128. How does the Uzi fly initiate its infestation on a silkworm batch?
(A) By biting the larvae and injecting a toxic venom
(B) By laying eggs inside the mulberry leaves which the silkworm then eats
(C) By destroying the silkworm eggs during incubation
(D) By laying eggs directly on the integument of late-instar larvae

2003

129. What distinct mark is left on the body of the silkworm larva at the site where an Uzi fly maggot has successfully penetrated the integument?
(A) A prominent black scar
(B) A white powdery ring
(C) A deep red blister
(D) A translucent bubble

NODIA

2005

130. Consider the following statements regarding the lifecycle and damage of the Uzi fly:
I. The Uzi maggot feeds entirely on the internal tissues of the silkworm larva.
II. Upon maturity, the maggot pierces out of the silkworm or the cocoon, rendering the cocoon unreelable.
III. The Uzi fly pupates exclusively inside the midgut of the dead silkworm.
IV. Providing wire mesh to doors and windows effectively reduces adult fly entry.
V. Uzi fly infestation peaks during heavy winter freezes.
Which of the above statement(s) is/are INCORRECT?
(A) III and V
(B) I, II and IV
(C) II, IV and V
(D) I, III and V

2025

131. The biological control of Uzi flies often involves the release of Nesolynx thymus. What is the precise role of Nesolynx thymus?
(A) It is a hyperparasitoid that attacks the Uzi fly pupae.
(B) It is a viral pathogen that kills the adult Uzi fly.
(C) It is a predatory bird that feeds on flying insects.
(D) It is a pheromone trap that confuses male Uzi flies.

(B) 12 to 14 hours
(C) 3 to 4 hours
(D) 24 to 36 hours

2001

95. After artificial decoupling (separation) of the male and female moths, what is the immediate subsequent operation for the female moth?
(A) She is released into the wild to lay eggs on the leaves of the host trees.
(B) She is placed under a cellule.
(C) She is frozen immediately to preserve her genetics for future breeding programs.
(D) She is fed a specialized nectar diet to restore energy after the mating process.

2003

96. Which environmental parameter must be strictly minimized in the oviposition room to ensure females lay eggs in a concentrated, orderly manner?
(A) Humidity
(B) Atmospheric carbon dioxide
(C) Room temperature (must be kept below 10°C)
(D) Light intensity (maintained in dim light/ darkness)

2008

97. The process of removing unfertilized or poorly formed eggs from an egg card by washing is part of:
(A) Egg surface sterilization
(B) Acid treatment
(C) Brushing
(D) Stifling

2015

98. How are the male moths practically managed in a commercial grainage after their first coupling?
(A) They are immediately crushed and used as fish feed after the first mating.
(B) They are placed in an oviposition cellule alongside the female moth to rest.
(C) They can be cold-stored and reused.
(D) They are allowed to fly to neighboring grainages to increase the local gene pool.

2004

99. The application of hydrochloric acid (HCl) to freshly laid bivoltine silkworm eggs is a standard procedure used for:
(A) Artificial termination of diapause.
(B) Hardening the eggshell to prevent physical damage during transport.
(C) Sterilizing the eggs against viral pathogens present on the chorion surface.
(D) Bleaching the eggs to a pure white color for better visibility in the trays.

2003

100. Arrange the following steps of the cold acid treatment method for artificial hatching in the correct sequence:
I. Washing the eggs in running water to remove acid traces
II. Drying the eggs in shade
III. Dipping the eggs in HCl (specific gravity 1.11) at 24°C for 60-90 minutes
IV. Allowing the freshly laid eggs to rest for 20-24 hours
(A) IV, III, I, II
(B) III, I, IV, II
(C) IV, I, III, II
(D) III, IV, II, I

2003

101. Cold storage of silkworm eggs is heavily utilized in the sericulture industry. What is its principal economic utility?
(A) To artificially induce mutations for new breed development in research.
(B) To synchronize brushing schedules.
(C) To completely permanently arrest the metabolic activity of the eggs in storage.
(D) To increase the overall size of the subsequent larvae during the final instar.

2018

102. What happens if diapausing bivoltine eggs are kept continuously at room temperature (25°C) without any acid treatment or wintering (cold storage)?
(A) They hatch within 10 days normally if the humidity levels are kept very high.
(B) They transform into multivoltine eggs automatically through physiological shifts.
(C) They will die due to nutrient depletion.
(D) They secrete an acidic fluid and dissolve their own chorion to escape the shell.

2018

103. In the hot acid treatment technique for breaking diapause, what is the standard temperature of the hydrochloric acid solution?
(A) 24°C
(B) 35°C
(C) 65°C
(D) 46°C

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2002

141. "Vijetha" is a very popular commercial product used in sericulture. What is its exact classification and application?
(A) A liquid foliar fertilizer sprayed on mulberry fields to increase yield.
(B) A hormone analog injected into pupae to extend the silk spinning time.
(C) A chemical used to dissolve sericin during reeling in commercial filatures.
(D) A powdered bed disinfectant.

2010

142. For maximum efficacy without disrupting feeding, when is a bed disinfectant like Vijetha or Ankush typically applied during the late instars?
(A) Immediately after brushing the newly hatched larvae onto the rearing bed.
(B) When the larvae are actively moulting and remain immobile on the leaves.
(C) Application after moult.
(D) Continuously mixed with the chopped mulberry leaves during the whole stage.

2001

143. Formalin (formaldehyde solution) is a highly effective room disinfectant. What is the standard concentration of the aqueous formalin solution used for spraying rearing houses and appliances?
(A) 0.5%
(B) 2.0%
(C) 10.0%
(D) 25.0%

2023

144. Which chemical is frequently combined with bleaching powder to create a potent paste or solution for sanitizing rearing trays and floors?
(A) Sodium chloride
(B) Potassium permanganate
(C) Copper sulfate
(D) Slaked lime (Calcium hydroxide)

2008

145. Match the items in List I with the functions in List II.
List I: (Disinfectant or hygiene practice)
P. 2% Bleaching powder solution
Q. Paraffin paper
R. Vijetha dust
S. Hand washing with antiseptic soap
List II: (Primary target/function)
1. Prevention of secondary human-to-larva pathogen transfer
2. Bed disinfection to prevent cross-infection among larvae
3. Total sanitation of rearing room floor and walls prior to rearing
4. Maintaining microclimate humidity in chawki beds
(A) P-3, Q-4, R-2, S-1
(B) P-2, Q-3, R-4, S-1
(C) P-4, Q-1, R-2, S-3
(D) P-3, Q-2, R-1, S-4

2021

146. A fumigant heavily relies on generating toxic gas to sterilize a room. What is the critical structural prerequisite for successful fumigation of a rearing house?
(A) The room must have open cross-ventilation for the gas to spread evenly.
(B) The room temperature must be strictly below freezing for maximum effect.
(C) The room must be perfectly airtight.
(D) The floor must be flooded with water to increase the humidity of the room.

NODIA

2022

147. Sun drying of rearing appliances (like bamboo chandrikes) is considered an important sanitation protocol primarily because:
(A) UV radiation acts as a sterilant.
(B) It permanently prevents wood-boring insects from attacking the bamboo.
(C) It physically softens the bamboo strips for easier handling by farmers.
(D) It changes the color of the appliances to attract mature larvae to spin.

2001

148. On which day following spinning is it generally recommended to harvest bivoltine cocoons under standard tropical conditions?
(A) 2nd or 3rd day
(B) 5th or 6th day
(C) 12th or 13th day
(D) 15th or 16th day

2002

149. Harvesting the cocoons prematurely (e.g., on the 2nd day) leads to which severe problem during post-harvest processing?
(A) The silk fibroin turns completely into sericin during the harvest process.
(B) The prepupa ruptures, staining the cocoon.
(C) The cocoon shell becomes impossibly hard to boil for the reeling operations.
(D) The color of the cocoon turns black due to the oxidation of the silk protein.

2005

150. How is the "Shell Ratio" (SR%) of a cocoon mathematically calculated?

(A) $\frac{\text{Weight of pupa}}{\text{Weight of whole cocoon}} \times 100$

(B) $\frac{\text{Weight of cocoon shell}}{\text{Weight of pupa}} \times 100$

(C) $\frac{\text{Weight of cocoon shell}}{\text{Weight of whole cocoon}} \times 100$

(D) $\frac{\text{Weight of reeled silk}}{\text{Length of filament}} \times 100$

2018

151. What does the assessment parameter "Renditta" measure in the context of cocoon grading and reeling?

(A) The number of fresh cocoons required to produce 1 kilogram of raw silk

(B) The length in meters of a single continuous silk filament

(C) The number of breaks in the filament during reeling

(D) The weight in kilograms of fresh cocoons required to produce 1 kilogram of raw silk

2009

152. In commercial terminology, a lower Renditta value indicates:

(A) Superior cocoon quality and higher silk yield

(B) Inferior cocoon quality and lower silk yield

(C) High moisture content in the pupa

(D) A high proportion of double cocoons

2025

153. What is the fundamental purpose of the "stifling" process immediately following cocoon harvest and procurement?

(A) To wash the dirt off the outer surface of the cocoon after harvesting.

(B) To kill the pupa.

(C) To separate the sericin from the fibroin chemically in the boiling bath.

(D) To induce the pupa to shed its final skin before the transformation starts.

2018

154. Which of the following is considered the most modern, scientifically reliable, and widely practiced method of cocoon stifling in industrial filatures?

(A) Sun drying in open fields.

(B) Hot air stifling.

(C) Steam stifling in open baskets using high-pressure steam from a boiler.

(D) Immersing live cocoons in cold concentrated acid to stop metabolic activity.

2025

155. The Central Silk Board (CSB), a statutory body under the Ministry of Textiles, Government of India, is headquartered in which city?

(A) Bangalore (Bengaluru)

(B) New Delhi

(C) Mysore

(D) Berhampore

2004

156. The Central Sericultural Research and Training Institute (CSRTI), dedicated primarily to research on mulberry sericulture in South India, is located at:

(A) Pampore

(B) Lahdoigarh

(C) Mysore

(D) Ranchi

2019

157. Which premier institute under the Central Silk Board is specifically mandated to conduct research on the Muga and Eri silkworms?

(A) CSRTI, Berhampore

(B) CTRTI, Ranchi

(C) SSTL, Kodathi

(D) CMERTI, Lahdoigarh (Jorhat)

2004

158. The concept of "Bivoltine Sericulture Technology" in India, which revolutionized high-quality silk production, was heavily developed through collaborative projects between the Central Silk Board and which international agency?

(A) Food and Agriculture Organization (FAO)

(B) World Bank

(C) Japan International Cooperation Agency (JICA)

(D) United Nations Development Programme (UNDP)

2021

159. In the organizational structure of Indian sericulture, what is the primary role of the State Sericulture Departments?

(A) Conducting basic molecular genetics research for the development of breeds.

(B) Extension and direct farmer assistance.

(C) Exporting raw silk to international markets for the textile industry.

(D) Fixing the minimum support price of finished silk fabrics at the retail level.

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160. What specialized function is performed by the Silkworm Seed Technology Laboratory (SSTL) under the Central Silk Board?

(A) Breeding new hybrid varieties of mulberry trees for higher leaf production.

(B) Manufacturing automated reeling machines for the modern industrial filatures.

(C) Marketing handloom silk garments through government-sponsored textile stores.

(D) Setting standards for seed production.

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require a long period of wintering or cold storage for their eggs to hatch, making them suitable for temperate climates with distinct seasons.

39. (B) They bypass embryonic diapause.
Polyvoltine silkworm strains are particularly well-adapted to tropical climates because they do not undergo embryonic diapause. This allows them to complete multiple life cycles in a single year, providing a continuous supply of cocoons for the silk industry. In regions like southern India, where temperatures remain relatively stable, these strains can be reared year-round without the need for artificial hatching treatments.

40. (A) Univoltine → Bivoltine → Polyvoltine
The classification of silkworms based on the number of generations they complete annually follows a clear progression. Univoltine strains produce only one generation per year, typically in temperate regions. Bivoltine strains complete two generations, while polyvoltine strains produce many generations annually. This hierarchy reflects the adaptation of different breeds to varying climatic conditions and the availability of mulberry leaves throughout the year.

41. (B) They will be non-diapausing eggs.
In bivoltine silkworms, the environmental conditions during the incubation of the eggs directly influence the voltism of the next generation. If the eggs are incubated at a low temperature around fifteen degrees Celsius and kept in darkness, the resulting moths will lay non-diapausing eggs. This physiological response allows the silkworms to adapt to cooler conditions by producing offspring that can hatch immediately.

42. (B) Enhancing glycogen conversion to sorbitol and glycerol
The diapause hormone triggers specific biochemical changes in the developing ovaries to prepare the eggs for metabolic arrest. One of its primary targets is the regulation of carbohydrate metabolism, where it promotes the conversion of glycogen into polyols like sorbitol and glycerol. these substances act as cryoprotectants and energy reserves, ensuring the embryo survives long periods of dormancy during unfavorable environmental conditions.

43. (A) Ecdysone - Induces moulting and cuticle shedding
Ecdysone is a critical hormone in the silkworm's lifecycle, produced by the prothoracic glands. Its primary function is to initiate the moulting process, where the larva sheds its old cuticle and grows a new, larger one. This hormonal regulation ensures that the larva can expand in size as it grows, which is essential for its development toward the final spinning stage.

44. (C) Heavier cocoon weight.
Juvenile Hormone analogues are sometimes used in sericulture to extend the duration of the fifth larval instar. By delaying the onset of pupation, the larvae are given more time to feed and synthesize silk proteins in their glands. This extended feeding period typically results in a significant increase in the final cocoon weight, thereby enhancing the overall silk yield per batch.

45. (A) Both A and R are true and R is the correct explanation of A.
A trimoulter silkworm is characterized by undergoing only three moults during its entire larval development instead of the usual four. This phenomenon occurs due to the premature decrease in Juvenile Hormone levels, which signals the larva to begin metamorphosis earlier than normal. Consequently, the larval span is shortened, leading to an earlier transition into the pupal stage and cocoon formation.

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46. (C) Tetramoulter
Most commercial strains of the mulberry silkworm, Bombyx mori, are classified as tetramoulters. This means they naturally undergo four distinct moults during their larval life, dividing their growth period into five instars. This specific moulting pattern is favored in the industry as it balances the duration of rearing with the production of high-quality silk and optimal cocoon weight for reeling.

47. (B) Corpora allata
Juvenile Hormone is synthesized and released by the corpora allata, which are small endocrine glands located behind the silkworm's brain. This hormone is essential for maintaining the larva in its juvenile state and preventing premature metamorphosis. The levels of Juvenile Hormone decrease as the larva matures, eventually

10. (A) I and II
In sericulture, host plant specificity is a well-defined trait where mulberry species serve as the exclusive primary food for the domesticated mulberry silkworm. Similarly, Terminalia tomentosa, commonly known as Asan, is a major primary host for the tasar silkworm. However, castor is not the host for muga; it is specifically associated with the rearing of eri silkworms.

11. (A) It necessitates the synchronized cultivation of Morus species.
The strict dietary requirement of the mulberry silkworm means it cannot survive on any other plant species besides mulberry. This monophagous nature creates a biological dependency that forces farmers to align their silkworm rearing schedules with the leaf production cycles of mulberry plantations. Consequently, any interruption in the supply of fresh mulberry leaves directly impacts the viability of the crop.

12. (C) Muga silkworm - Castor (Ricinus communis)
The association between silkworms and their host plants is specific, and pairing the muga silkworm with castor is biologically incorrect. Castor is the primary host for the eri silkworm, whereas the muga silkworm depends on Som and Soalu trees. Understanding these correct pairings is essential for successful sericulture management and ensuring the larvae receive the appropriate nutrition for development.

13. (D) Eighth abdominal segment
Morphologically, the larvae of the mulberry silkworm possess a prominent, non-functional structure known as the caudal horn. This feature is located on the dorsal surface of the eighth abdominal segment. It serves as an important anatomical marker for identifying the species and assessing the developmental stage of the larvae during the various instars of their growth in the rearing bed.

14. (C) 9 pairs
The respiratory system of the silkworm larva relies on specialized openings called spiracles located along the sides of its body. There are exactly nine pairs of these structures, with one pair found on the first thoracic segment and eight pairs distributed across the abdominal segments. These spiracles facilitate the exchange of gases, ensuring the larva receives sufficient oxygen for its metabolism.

15. (A) Both A and R are true and R is the correct explanation of A.
Through thousands of years of intensive domestication and selective breeding for higher silk production, the adult mulberry silkworm moth has lost its ability to fly. The primary reasons include a significant increase in body weight and the degeneration of the wing muscles. These physical changes are a direct result of being reared in a protected, human-managed environment for generations.

16. (D) Crochets on the prolegs
To maintain a secure grip on leaves and rearing surfaces, silkworm larvae utilize specialized anatomical structures located on their abdominal prolegs. These tiny, hook-like structures, known as crochets, allow the larvae to anchor themselves firmly while feeding or moving. This adaptation is vital for preventing the larvae from falling, especially during the later instars when their body weight increases significantly.

17. (A) Maxillary gland
As the silkworm completes its metamorphosis and prepares to emerge from the cocoon, it must find a way to break through the tough silk layers. The adult moth secretes a specialized alkaline fluid from its maxillary glands. This fluid effectively softens the sericin binder in the silk, allowing the moth to push through the filaments and exit the cocoon without wings.

18. (C) The chorion is completely impermeable to oxygen.
The eggshell or chorion of a silkworm egg is a complex structure designed to protect the developing embryo while allowing for necessary biological processes. It is not impermeable; rather, it contains microscopic pores called aeropyles that facilitate the exchange of oxygen and carbon dioxide. This gas exchange is vital for the survival and growth of the embryo throughout the entire incubation period.

19. (A) It extrudes liquid silk which solidifies upon contact with air.
The spinneret is a specialized organ located on the labium of the silkworm larva. Its primary physiological role is to control the extrusion of liquid silk proteins produced by the silk glands. As this liquid passes through the spinneret and hits the air, it solidifies into a continuous

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filament, which the larva then uses to construct its protective cocoon.

20. (A) I, II and IV
The anatomy of the silkworm larva is characterized by a head composed of six fused segments and a thorax with three segments, each bearing true legs. The silk gland is an exocrine organ divided into three functional regions. However, the abdomen typically consists of ten segments rather than eleven, making the statement regarding the eleven abdominal segments in the larva incorrect.

21. (B) The female pupa is larger and features an X-shaped mark.
Distinguishing the sex of silkworms at the pupal stage is crucial for grainage operations. Female pupae are generally larger and heavier than males. A definitive morphological characteristic of the female is the presence of a distinct X-shaped mark on the ventral side of the eighth abdominal segment. Male pupae lack this mark and typically show a small dot-like structure instead.

22. (C) Posterior region
The silk gland of the silkworm is a highly specialized organ divided into three distinct functional parts. The posterior region is the site where the primary structural protein, fibroin, is synthesized. Once produced, this fibroin moves forward into the middle region for storage and coating, eventually reaching the anterior region before being extruded through the spinneret during the spinning process.

23. (D) 20-25%
Silk produced by the mulberry silkworm is a composite material consisting of two main proteins. Fibroin forms the structural core, while sericin acts as a water-soluble gummy substance that binds the filaments together. In a typical silk bave, sericin accounts for approximately twenty to twenty-five percent of the total weight, providing the necessary adhesion for the construction of the cocoon.

24. (A) The fibroin filaments will not adhere together.
Sericin is a vital gummy protein secreted by the middle region of the silk gland. Its primary function is to coat the two fibroin filaments as they pass through the gland. If the production of sericin is insufficient, the fibroin strands will fail to stick together properly. This results in a weak, poorly formed cocoon that is difficult for commercial reeling operations.

25. (A) P-2, Q-4, R-1, S-3
The biochemical and anatomical structures of the silkworm work in coordination to produce silk. Fibroin serves as the structural protein core, while sericin provides a gummy, water-soluble coating. Filippi's glands secrete a substance that helps lubricate the extrusion process. Finally, the anterior silk gland acts as a transport duct that carries the liquid silk forward to the spinneret for spinning.

26. (B) Glycine
The chemical composition of silk fibroin is dominated by a few specific amino acids that contribute to its unique physical properties. Glycine is the most abundant amino acid, making up a large portion of the protein's primary structure. Its small size allows for the tight packing of protein chains, which gives silk its characteristic strength, flexibility, and smooth texture in textile applications.

27. (A) Haemolymph
In the silkworm, the circulatory fluid known as haemolymph plays a vital role in transporting essential nutrients to various organs. During the fifth instar, when the silk glands are growing rapidly and synthesizing large amounts of protein, the haemolymph carries the necessary amino acids and energy sources to these glands. This efficient transport system is fundamental to the high productivity of the larvae.

28. (C) It provides the amino acids for protein synthesis.
The silkworm consumes large quantities of mulberry leaves to obtain the proteins required for silk production. Once ingested, these dietary proteins are broken down into their constituent amino acids within the midgut. These amino acids are then absorbed and transported to the silk glands, where they are reassembled into fibroin and sericin, the primary components of the silk filament.

29. (D) Morin
The feeding behavior of the mulberry silkworm is triggered by specific chemical compounds found within mulberry leaves. Morin is a key secondary

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metabolite that acts as a potent phagostimulant, specifically serving as a biting factor for the larvae. This chemical signal encourages the silkworm to begin feeding, ensuring it consumes the nutrition necessary for its rapid growth and subsequent silk production.

30. (B) III and IV
In artificial diet formulations for silkworms, various ingredients serve specific roles. While agar-agar acts as a gelling agent and soybean meal provides protein, cellulose powder is actually used as a bulk filler rather than a digestible energy source. Furthermore, ascorbic acid is a necessary nutrient that promotes growth, meaning its exclusion as an inhibitor in the diet description is factually incorrect.

31. (B) Fifth instar
The growth of a silkworm is characterized by a massive increase in body weight during its final larval stage. During the fifth instar, the larvae exhibit an enormous appetite, consuming nearly eighty to eighty-five percent of the total mulberry leaves they will eat in their entire lifetime. This intense feeding period is essential for the rapid development of the large silk glands.

32. (D) Sterols (e.g., β-sitosterol)
Silkworms are unable to synthesize sterols internally and must obtain them through their diet. Sterols like beta-sitosterol are critical precursors for the production of ecdysone, the hormone that regulates the moulting process. A deficiency in these essential nutrients leads to severe physiological disruptions, resulting in incomplete moults, physical deformities, and high mortality rates within the rearing batch, affecting overall productivity.

33. (A) Prefer tender leaves with high moisture and high protein content.
The nutritional requirements of silkworms change as they progress through their larval stages. Young age or chawki worms have delicate mouthparts and require tender, succulent mulberry leaves. These leaves must have high moisture and protein content to support rapid cellular growth and easy digestion. In contrast, older larvae can handle coarser leaves with higher fiber content as they mature.

34. (B) It promotes robust larval growth.
Ascorbic acid, commonly known as Vitamin C, is a vital nutritional component in the silkworm's diet. It plays a significant role in various metabolic processes and serves as an antioxidant. Providing sufficient levels of this vitamin ensures healthy development and robust growth of the larvae. This leads to higher survival rates and better quality cocoons, which are essential for commercial sericulture success.

35. (A) It serves as a precursor for the synthesis of ecdysone.
Phytosterols like sitosterol, found in mulberry leaves, are indispensable for the hormonal balance of the silkworm. They are converted by the larvae into ecdysteroids, primarily ecdysone, which is the hormone responsible for triggering the moulting process. Without an adequate supply of these sterols in their diet, the larvae cannot successfully transition between developmental stages, leading to growth arrest and death.

36. (D) Photoperiod and temperature
The phenomenon of voltism in bivoltine silkworms is primarily governed by environmental cues received during the embryonic stage. Specifically, the duration of light and the surrounding temperature during egg incubation determine whether the resulting female moths will lay diapausing or non-diapausing eggs. This physiological mechanism allows the species to synchronize its lifecycle with the changing seasons and availability of food sources.

37. (B) Suboesophageal ganglion
Diapause in silkworms is a survival strategy controlled by a specific hormone secreted by the suboesophageal ganglion of the mother moth. This diapause hormone acts on the developing ovaries to ensure that the eggs laid will enter a state of metabolic arrest. This hormonal regulation is essential for allowing the species to survive adverse environmental conditions by pausing development at the embryonic stage.

38. (C) Obligate univoltine
Certain silkworm strains are genetically programmed to complete only one generation per year, a trait known as univoltinism. When this characteristic is fixed and occurs regardless of favorable environmental factors, the strain is termed obligate univoltine. Such breeds typically

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57. (B) East-West direction (longer axis running East-West)
In tropical regions, the orientation of the silkworm rearing house is crucial for managing internal temperatures. By aligning the longer axis of the building in an east-west direction, the side walls are less exposed to the direct rays of the morning and afternoon sun. This design helps maintain a cooler indoor environment, which is vital for the health and productivity of the larvae.

58. (B) Relative Humidity
During the early stages of silkworm growth, known as chawki rearing, the larvae are extremely sensitive to environmental conditions. It is essential to maintain a higher relative humidity, typically between eighty-five and ninety percent, to prevent the tender chopped mulberry leaves from drying out. High humidity ensures the larvae can continue feeding easily, which is necessary for their rapid development and survival.

59. (A) To dissipate metabolic heat.
During the fifth instar, silkworm larvae consume enormous amounts of food and undergo rapid growth, which generates a significant amount of metabolic heat. Without proper cross-ventilation, this heat can accumulate in the rearing house, causing thermal stress and increasing the risk of disease. Effective air circulation is therefore critical for maintaining the health of the larvae and ensuring high-quality cocoon production.

60. (A) I and II
Designing an effective rearing house requires attention to thermal management. Using roofing materials with low thermal conductivity helps keep the interior cool, and adding a verandah around the building provides an additional buffer against external temperature extremes. While some light control is necessary, the idea that floor-to-ceiling windows on all sides are mandatory for maintaining darkness is structurally and logically incorrect.

61. (D) To protect from vertebrate predators.
Silkworm larvae and pupae are vulnerable to attacks from various vertebrate pests, including rats and squirrels. Installing a rat-proof mesh or creating a water-filled trench around the foundation of the rearing house provides a physical barrier against these predators. This protection is vital for preventing crop losses and ensuring that the larvae can develop and spin their cocoons without being disturbed or eaten.

62. (C) It provides adequate air volume per unit of rearing space.
The height of the side walls in a rearing house is a key factor in ensuring proper environmental control. A height of ten to twelve feet ensures there is a sufficient volume of air within the room to dilute carbon dioxide and other gases. This large air volume also helps in better temperature regulation and provides a more comfortable and hygienic atmosphere for the developing silkworms.

63. (B) Asbestos or galvanized iron sheets
In hot tropical climates, materials like asbestos or galvanized iron sheets are poor choices for roofing because they absorb and radiate a large amount of solar heat. This can lead to dangerously high temperatures inside the rearing house. Unless a false ceiling or other insulation is provided, these materials can negatively affect larval health, leading to poor growth and increased susceptibility to diseases.

64. (D) It serves as a support structure for larvae to spin their cocoons.
A Chandrike is a traditional bamboo mountage used extensively in Indian sericulture. It consists of a flat board with spiral bamboo strips that provide multiple crevices and support points for the mature silkworm larvae. When the larvae are ready to spin their cocoons, they are placed on the Chandrike, where they anchor themselves and begin the intricate process of filament extrusion.

65. (A) To prevent leaf drying.
Foam pads are important accessories used during the rearing of young age silkworms. These pads are soaked in water and placed around the edges of the rearing bed before covering it with paraffin paper. This practice creates a high-humidity microclimate that prevents the finely chopped tender mulberry leaves from withering quickly, ensuring that the delicate chawki larvae have access to fresh food.

66. (C) Mesh size separates larvae from waste.
Bed cleaning is a vital hygiene operation that involves the use of specialized cleaning nets. The choice of mesh size is determined by the size of the larvae at their specific developmental stage. The net allows the silkworms to crawl through

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allowing ecdysone to trigger the transformation into a pupa and then an adult.

48. (D) It anchors itself with its head raised.
When a silkworm is ready to undergo a moult, it exhibits a very specific behavioral change. The larva stops feeding and searches for a stable spot in the rearing bed. It then anchors its posterior end and remains stationary with its head held in a characteristic raised position. This period of inactivity is necessary for the physiological processes involved in shedding the old skin.

49. (A) Anti-Juvenile Hormone agent
Precocene is a chemical compound used in entomological research to study the effects of hormones on insect development. In the context of sericulture, it acts as an anti-juvenile hormone agent by interfering with the function of the corpora allata. By suppressing the levels of Juvenile Hormone, precocene can induce premature metamorphosis in larvae, providing insights into the endocrine regulation of growth.

50. (B) III, I, IV, II
The cocoon shell ratio, which measures the percentage of silk in a whole cocoon, varies significantly across different silkworm breeds. Indigenous multivoltine breeds like Nistari generally have the lowest ratios, followed by Pure Mysore. Standard bivoltine breeds like NB4D2 show higher values, while highly productive modern bivoltine hybrids like CSR2 exhibit the highest shell ratios, reflecting years of intensive genetic improvement.

51. (A) Greenish-yellow pointed cocoons and multivoltine nature
Pure Mysore is a renowned indigenous silkworm breed from southern India, specifically the state of Karnataka. It is characterized by its hardy multivoltine nature, which allows for multiple crops per year. The cocoons produced by this breed are distinctively greenish-yellow in color and have a pointed, spindle shape. These traits make it a vital component in many cross-breeding programs.

52. (D) To combine disease resistance with silk yield.
In India, the production of Multi x Bi hybrids is a strategic practice aimed at balancing the benefits of different silkworm types. Multivoltine breeds provide excellent disease resistance and tolerance to tropical climates, while bivoltine breeds contribute superior silk quality and higher yields. By crossing them, sericulturists create hybrids that are both robust for farmers and commercially valuable for the industry.

53. (B) Shungetsu x Hosho
To improve the productivity and quality of Indian silk, several exotic bivoltine breeds have been introduced from countries with advanced sericulture, like Japan. Shungetsu x Hosho is a classic example of such an exotic breed. These strains are frequently used in hybridization programs to infuse superior genetic traits, such as high filament length and better cocoon shell percentage, into local silkworm populations.

54. (C) European breeds are usually multivoltine with very short larval spans.
The classification of silkworm breeds based on their geographical origin reveals distinct characteristics. Japanese breeds are known for peanut-shaped cocoons, while Chinese breeds often produce oval ones. Indian indigenous breeds are noted for their environmental tolerance. However, European breeds are typically univoltine and have relatively long larval spans, which contradicts the idea that they are multivoltine with short growth periods.

55. (A) P-3, Q-1, R-4, S-2
Different silkworm breeds are classified by their distinct production and morphological traits. European breeds are typically univoltine with large cocoons, while Pure Mysore is a hardier multivoltine variety. Japanese breeds are famous for their peanut-shaped cocoons. Furthermore, the CSR hybrids represent modern high-yield varieties developed specifically by CSRTI Mysore to thrive in tropical environments and boost national silk output.

56. (A) Heterosis (Hybrid vigor)
The primary goal of using F1 hybrids in commercial sericulture is to exploit the biological phenomenon of heterosis. This hybrid vigor results in offspring that perform better than either of their parents in terms of growth rate, disease resistance, and total silk yield. By utilizing hybrids, farmers can achieve more consistent and productive crops, which is essential for the economic viability of sericulture.

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ANSWERS

1. (A) Antheraea assamensis
The silkworm variety known for producing the golden muga silk belongs to the family Saturniidae, which includes many wild and semi-wild species. These insects are characterized by their large body size and the presence of prominent eye spots on their wings. This specific species is endemic to the Brahmaputra Valley and remains highly valued for commercial sericulture.

2. (C) Central China
Historical and genetic evidence indicates that the mulberry silkworm originated in East Asia, specifically within the central regions of China. This area served as the primary center for the domestication of the species from its wild ancestor. Over thousands of years, selective breeding in this region led to the highly productive strains currently utilized in global silk production.

3. (A) Bombycidae are fully domesticated, while commercial Saturniidae remain wild.
A primary distinction in sericulture classification involves the degree of human intervention in the lifecycle. Members of the family Bombycidae have undergone complete domestication, losing their ability to survive in the wild or fly. In contrast, many commercially significant species within the Saturniidae family are still reared in outdoor environments and retain many of their natural wild characteristics.

4. (D) It is strictly monophagous, feeding only on castor leaves.
The muga silkworm is classified as a polyphagous insect rather than a monophagous one. While it primarily feeds on Som and Soalu plants, it does not depend on castor leaves, which are the primary food source for the eri silkworm. Its endemic nature in Northeast India and its taxonomic placement within the order Lepidoptera are well-established scientific facts.

5. (B) Identifying compatible parent species for interspecific hybridization.
Systematic taxonomy provides the biological foundation necessary for successful breeding programs in sericulture. By understanding the evolutionary relationships and genetic proximity between different silkworm species, scientists can accurately identify compatible parents for hybridization. This application is vital for creating robust hybrids that combine high silk yield with resistance to environmental stressors and various lethal pathogens.

6. (C) The central and eastern tropical forest belt
The tropical tasar silkworm is indigenous to the vast forest tracts of central and eastern India. This geographical belt provides the ideal climatic conditions and an abundance of primary host plants, such as Asan and Arjun trees. The distribution covers several states where tribal communities have traditionally engaged in the outdoor rearing of these wild silkworm species for centuries.

7. (D) Eri silkworm - Ricinus communis
The eri silkworm is famously known for its dependence on the castor plant as its primary food source. This relationship is a fundamental aspect of non-mulberry sericulture, as the nutritional profile of castor leaves is essential for the healthy development of this specific larvae. Other silkworms, like muga and tasar, rely on different host plants such as Som or Arjun.

8. (A) Antheraea assamensis
The Som plant is a critical primary host for the muga silkworm found in the northeastern regions of India. The nutritional quality of these leaves directly influences the health of the larvae and the quality of the golden silk produced. Proper management of Som plantations is essential for sustaining the muga silk industry and ensuring consistent yields for the farmers.

9. (B) Ziziphus mauritiana (Ber)
While the tropical tasar silkworm prefers primary hosts like Arjun and Asan, it can also thrive on certain secondary host plants. The Ber tree is recognized as a significant secondary food source that supports larval growth when primary hosts are unavailable. Utilizing secondary hosts allows for greater flexibility in rearing practices and helps maintain silkworm populations across diverse ecological settings.

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to the fresh leaves placed on top, while the old leaves, excreta, and other waste remain below for easy removal and disposal.

67. (A) Under the legs of the rearing stands
Ants are persistent pests that can destroy a silkworm crop by attacking the larvae on the rearing trays. To prevent this, ant wells are placed under each leg of the rearing stands. These wells are filled with water or oil, creating a liquid barrier that ants cannot cross. This simple yet effective mechanical control measure is essential for maintaining the safety of the silkworm batch.

68. (D) Leaf chopping block and knife
Early instar silkworms, especially in the first and second stages, have small mouthparts and require finely chopped mulberry leaves for easy feeding. A dedicated leaf chopping block and a sharp knife are essential appliances for ensuring that the leaves are cut uniformly into the appropriate size. This precise preparation of food supports healthy growth and uniform development across the entire rearing batch.

69. (B) It ensures uniform spinning.
The rotary mountage is a modern alternative to traditional bamboo structures, designed to improve the quality of cocoon production. Its structure allows each silkworm to occupy an individual cell, which prevents the formation of double cocoons and ensures uniform air circulation. This results in cocoons that are more consistent in shape and size, making them much easier to process in commercial reeling machines.

70. (A) I, II and IV
Successful sericulture relies on a variety of specialized appliances. Paraffin paper and foam pads are used to maintain humidity in chawki beds, while feather brushes allow for the gentle handling of newly hatched larvae. Wooden or bamboo trays provide the primary housing for the worms. However, mountages must never be airtight, as proper ventilation is essential during the silk spinning process.

71. (D) The first and second larval instars
Chawki rearing is a specialized phase in sericulture that focuses on the management of the first and second larval instars. These young silkworms are extremely delicate and require precise environmental controls and high-quality nutrition to ensure a high survival rate. Successful chawki rearing is considered the foundation of a productive cocoon crop, as it determines the health of the larvae in later stages.

72. (A) 27°C - 28°C
Maintaining an optimal temperature is critical for the rapid metabolic processes of young silkworms. For chawki rearing, a temperature range between twenty-seven and twenty-eight degrees Celsius is recommended. This warmth encourages active feeding and uniform growth, allowing the larvae to quickly pass through their first two moults. Deviations from this range can lead to sluggishness or increased susceptibility to various larval diseases.

73. (B) The poor survival rate of young larvae.
The establishment of Chawki Rearing Centers was a strategic move to improve the overall productivity of the silk industry. Many individual farmers lack the specialized equipment and skills needed to manage the highly sensitive early larval stages. By centralizing this process in dedicated centers, the industry has significantly improved the survival and health of young silkworms, leading to better results for the farmers.

74. (B) Feeding finely chopped tender succulent leaves at frequent intervals
To support the rapid growth of young silkworms, the feeding strategy must be carefully managed. Providing finely chopped, tender mulberry leaves ensures that the larvae can consume the food easily with their small mouthparts. Frequent feeding intervals are necessary because the high-protein succulent leaves are digested quickly. This intensive care during the chawki stage is essential for building a robust larval population.

75. (A) Both A and R are true and R is the correct explanation of A.
High relative humidity is vital in the chawki rearing environment because young larvae are very sensitive to dehydration. More importantly, high humidity prevents the finely chopped tender leaves from drying out and becoming too hard for the larvae to eat. By keeping the food fresh and moist, sericulturists ensure continuous and effective feeding, which is necessary for the healthy development of the crop.

76. (C) To ensure synchronized hatching.
Black boxing is a technique where silkworm eggs are kept in complete darkness once they reach

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the "blue egg" stage. This darkness arrests the development of the more advanced embryos until the rest catch up. When the eggs are finally exposed to bright light on the expected day of hatching, it triggers a synchronized emergence of larvae, which is essential for uniform rearing.

77. (D) The technical transfer of newly hatched larvae from egg cards to rearing beds.
Brushing is the first critical operation performed once the silkworm eggs hatch. It involves gently transferring the tiny, newly emerged larvae from the egg cards onto the rearing beds prepared with chopped mulberry leaves. This process must be done with great care, often using a soft feather, to avoid injuring the delicate larvae. Proper brushing ensures a healthy start for the entire rearing cycle.

78. (C) It reduces labor costs.
Shoot rearing is a modern method used for the later stages of silkworm development, where whole mulberry branches are provided as food. This technique is significantly more efficient than individual leaf feeding because it eliminates the time-consuming tasks of leaf picking and chopping. Consequently, it greatly reduces the labor requirements for the farmer, making large-scale sericulture operations more economically viable and manageable.

79. (B) Late-age worms require slightly lower temperatures and lower humidity with excellent ventilation.
As silkworms mature into the fourth and fifth instars, their environmental needs change compared to the chawki stage. These larger larvae generate more metabolic heat and moisture, making them more comfortable at slightly lower temperatures and humidity levels. Furthermore, excellent ventilation becomes paramount during this phase to remove excess moisture and gases, ensuring the health of the larvae during their most productive period.

80. (A) I and V
Late-age floor rearing is a method that requires significant floor space, making it less suitable for farmers with limited room. It involves feeding larvae on raised platforms or the floor with whole branches. While it improves air circulation, it does not eliminate the need for mountages, as the larvae still require a structure to spin their cocoons once they reach the ripening stage.

81. (A) Daily
In a tray rearing system for fifth instar silkworms, daily bed cleaning is essential for maintaining a hygienic environment. At this stage, the larvae consume large amounts of leaves and produce significant quantities of excreta. If this waste is not removed daily, it can lead to the accumulation of moisture and pathogens, which increases the risk of devastating diseases like flacherie and grasserie.

82. (C) The body becomes translucent.
As a silkworm larva reaches the end of its final instar and prepares to spin its cocoon, it undergo several physiological changes. One of the most prominent signs is that the body stops feeding and becomes translucent or yellowish in appearance. This change indicates that the silk glands are fully engorged with liquid silk, and the larva is ready to be transferred to the mountage.

83. (A) Mounting
Mounting is the critical process of identifying ripe silkworm larvae and transferring them to a mountage structure, such as a Chandrike. This operation must be timed carefully; if larvae are mounted too early or too late, it can negatively affect the quality of the silk and the shape of the cocoon. Proper mounting ensures that the larvae have the best environment for spinning.

84. (D) Enhanced silk quality and uniform cocoon shape
Overcrowding in a silkworm rearing bed is highly detrimental to the health and productivity of the batch. It leads to uneven growth, as larvae compete for space and food, and creates a poor microclimate that fosters disease. Under no circumstances does overcrowding enhance silk quality; instead, it typically results in inferior cocoons and increased mortality rates, which can lead to significant economic losses.

85. (A) P-3, Q-1, R-2, S-4
Different non-mulberry silkworm species are characterized by their unique rearing environments. Tropical tasar silkworms are reared outdoors on forest trees, while muga silkworms are endemic to Assam and also reared outside. In contrast, the eri silkworm is uniquely suited for indoor rearing on castor leaves. Oak tasar silkworms are specifically managed in the

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sub-Himalayan belts on various Quercus species, reflecting their ecological adaptations.

86. (C) Its larvae lack the strong wandering instinct.
The eri silkworm is the only non-mulberry species that is fully domesticated and reared indoors. This is largely because the larvae do not exhibit the strong wandering behavior seen in other wild silk-producing insects. This trait allows farmers to manage them easily in trays or on floors, similar to the mulberry silkworm, which simplifies the rearing process and protects the crop from external predators.

87. (D) To facilitate collection for mounting.
In the outdoor rearing of muga silkworms, managing the ripe larvae as they prepare to spin is a challenge. By tying a 'Chaloni' or protective band around the tree trunk, farmers can intercept the larvae as they crawl down to find a spinning site. This device makes it much easier for the farmers to collect the mature worms and transfer them to indoor mountages.

88. (A) Attack by natural predators.
Rearing tropical tasar silkworms outdoors exposes them to a wide range of natural enemies, including insectivorous birds, bats, and predatory insects. These predators can cause devastating losses to the larval population, especially in the later instars. Managing these risks is a significant challenge for tasar silk farmers, who often rely on traditional methods and nets to protect their precious outdoor silkworm crops.

89. (B) Chawki garden rearing / Nylon net rearing
To improve the survival of young tasar silkworms, a semi-controlled rearing practice is often employed. This involves placing the young larvae on small host trees covered with nylon nets. This "chawki garden" approach protects the delicate early instars from predators and harsh weather while still allowing them to feed in a natural environment. Once they grow stronger, they are moved to larger trees.

90. (A) Brushing on trees → Transfer of worms to fresh trees → Collection of ripe worms → Mounting
The outdoor rearing of muga silkworms follows a logical sequence of operations. It begins with brushing newly hatched larvae onto the host trees. As the larvae consume the available foliage, they must be transferred to fresh trees to ensure continued nutrition. Finally, when the larvae mature and become ripe, they are collected from the tree trunks and placed on mountages to spin cocoons.

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91. (A) The thread is discontinuous.
Unlike the mulberry silkworm, the eri silkworm does not produce a single, continuous silk filament. Instead, the cocoon is constructed in a way that results in a discontinuous thread, which makes it impossible to reel in the traditional sense. Consequently, eri silk must be processed through spinning, similar to cotton or wool, which gives the resulting fabric its unique and distinctive texture.

92. (C) The production of disease-free layings.
Grainage is a specialized facility in the sericulture industry dedicated to the scientific production of high-quality silkworm seeds, known as disease-free layings (DFLs). The primary goal of a grainage is to ensure that the eggs supplied to farmers are free from pathogens, especially the devastating pebrine disease. This process involves careful moth examination, controlled mating, and proper egg processing to ensure healthy crops.

93. (D) To microscopically detect pebrine spores.
The most critical step in grainage operations is the mother moth examination. After a female silkworm moth has laid her eggs, her body is crushed and examined under a microscope. This scientific procedure is designed to detect the presence of Nosema bombycis spores, the causative agent of pebrine. If the moth is infected, her eggs are destroyed to prevent the vertical transmission of the disease.

94. (C) 3 to 4 hours
In grainage operations, the mating of male and female moths is carefully timed to ensure maximum fertilization of the eggs. A standard duration of three to four hours is generally recommended for successful coupling. This period is sufficient for the transfer of sperm to the female. After this time, the moths are decoupled, and the females are placed in specialized cells for egg-laying.

95. (B) She is placed under a cellule.
Once the mating period is complete and the moths have been decoupled, the female silkworm moth is immediately placed under a specialized

significantly reducing the damage and mortality caused by this common sericulture pest.

133. (B) Pupal stage
After the mature Uzi fly maggot emerges from its host, it searches for a dark, sheltered place to undergo pupation. Common sites include the corners of the rearing room, crevices in the walls, or the loose soil outside. During this pupal stage, the fly is immobile and protected within a hard casing. Understanding this behavior is important for farmers, as it allows them to target these areas during cleaning and disinfection.

134. (C) Boring into cocoons and cutting filaments.
Dermestid beetles are a major nuisance in cocoon storage and grainage facilities. The larvae of these beetles are highly destructive, as they have strong mouthparts capable of boring through the tough layers of the cocoon shell to feed on the pupa inside. In the process, they cut the continuous silk filaments, rendering the cocoons unreelable and causing significant economic losses to both farmers and reelers.

135. (A) Both A and R are true and R is the correct explanation of A.
Proper storage practices are essential for preventing the spread of dermestid beetles. Pierced cocoons, which are often discarded or used for spinning, are a primary breeding ground for these pests. If stored near fresh seed cocoons, the beetle larvae can easily migrate and infest the healthy stock, leading to widespread damage. Completely enclosing and separating these storage areas is a vital measure for maintaining cocoon quality.

136. (A) Using ant wells on rearing stands.
Ants are attracted to the high-protein environment of the silkworm rearing bed and can quickly decimate a batch of young larvae. The most standard and effective preventive measure is the use of ant wells. These small containers are filled with water or oil and placed under the legs of the rearing stands. This creates a barrier that ants cannot cross, effectively protecting the larvae from these common crawling predators.

137. (B) Insectivorous birds and bats
In the outdoor rearing of non-mulberry silkworms like tasar and muga, vertebrate predators pose a significant threat. Various species of insectivorous birds and bats can consume large numbers of larvae directly from the host trees. These predators are difficult to control in an open forest environment, making the protection of outdoor crops a major challenge for farmers, who often use nets and noise to deter them.

138. (B) They suck hemolymph from adult moths.
Mites belonging to the genus Pyemotes can become serious pests in silkworm grainages. These tiny arachnids are external parasites that attach themselves to the bodies of adult silkworm moths. Once attached, they feed by sucking the hemolymph of the moths, which can weaken them and significantly reduce their egg-laying capacity. Managing mite infestations is important for maintaining the health and productivity of the seed-producing moths.

139. (A) Periodic fumigation and disposal.
To control dermestid beetles in cocoon storage areas, a combination of hygiene and chemical control is necessary. Periodic fumigation with approved chemicals can effectively kill both the adult beetles and their larvae hidden within the cocoons. Furthermore, regular disposal of waste and pierced cocoons prevents the beetles from establishing a permanent population. These practices are essential for protecting the economic value of the stored silk cocoons.

140. (C) Using sticky traps or water pans.
In addition to chemical and biological methods, simple mechanical traps can be used to manage Uzi fly populations inside rearing rooms. Sticky traps or pans filled with water and a small amount of detergent can attract and trap the adult flies. These traps are often placed near light sources or windows where the flies are likely to congregate, providing a low-cost way to reduce the number of active parasites.

141. (D) A powdered bed disinfectant.
Vijetha is a widely used commercial product in the Indian sericulture industry, specifically designed as a bed disinfectant. It is a powdered formulation containing a mix of chemicals that target various silkworm pathogens, including viruses, bacteria, and fungi. By applying Vijetha to the rearing bed, farmers can prevent cross-infection between larvae, ensuring a healthier crop and reducing the risks associated with common silkworm diseases.

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the natural winter environment while providing the protection needed for the embryos to survive until they are ready for incubation.

105. (A) Both A and R are true and R is the correct explanation of A.
After treating silkworm eggs with hydrochloric acid to terminate diapause, it is absolutely essential to wash them thoroughly with running water. Any remaining traces of acid on the egg surface can seep through the micropyle and damage the internal embryonic tissues. This can lead to chemical burns and high mortality rates, making the washing step a critical component of successful egg processing.

106. (B) Disease Free Laying
In the sericulture industry, the term DFL stands for Disease Free Laying. This refers to a single batch of silkworm eggs produced by a mother moth that has been scientifically examined and cleared of pathogens, particularly the pebrine disease. DFLs are the standard unit of trade for silkworm seeds, ensuring that farmers receive healthy stock that is likely to produce a successful cocoon crop.

107. (A) Cost of purchasing seed cocoons
For a commercial grainage, the largest variable expense is typically the procurement of high-quality seed cocoons. These cocoons serve as the raw material for moth emergence and subsequent egg production. The price of these cocoons fluctuates based on market demand and quality, directly impacting the overall cost of producing disease-free layings. Efficient management of this cost is key to the economic success of the grainage.

108. (C) 450 - 550 eggs
A standard disease-free laying of a bivoltine hybrid silkworm typically contains between four hundred and fifty to five hundred and fifty eggs. This number is used as a benchmark for calculating the potential yield of a rearing batch. Ensuring a consistent egg count per DFL is important for farmers to accurately plan their mulberry leaf requirements and manage their rearing house space and labor effectively.

109. (B) Optimizing moth emergence and pairing.
To maintain profitability, a grainage must maximize the efficiency of its biological processes. This involves ensuring that moths emerge simultaneously and that mating and egg-laying are highly successful. By optimizing moth emergence and pairing, the grainage can produce more disease-free layings from a given number of seed cocoons. This efficiency reduces waste and improves the overall cost-benefit ratio of the seed production center.

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110. (A) I and II
The economic health of a seed production center is measured by its recovery percentage and its ability to maintain disease-free standards. A high recovery rate of DFLs from processed seed cocoons indicates operational efficiency. Conversely, any incidence of pebrine can lead to the total destruction of egg batches, causing severe financial losses. While profitability varies, selling DFLs is generally the primary objective of specialized grainages.

111. (B) Asynchronous moth emergence.
One of the most significant hidden losses in grainage operations occurs when male and female moths do not emerge at the same time. This asynchrony leads to a shortage of mates, requiring the expensive storage of early-emerging moths or the loss of uncoupled females. Improving the synchronization of emergence through precise temperature and light control is vital for reducing costs and maximizing the production of DFLs.

112. (B) 60 - 70 DFLs
In a highly efficient bivoltine grainage operation, the recovery rate is a key metric of performance. Typically, one kilogram of high-quality seed cocoons can yield approximately sixty to seventy disease-free layings. This ratio depends on several factors, including the breed of the silkworm, the health of the pupae, and the precision of the grainage techniques used for moth emergence and egg collection.

113. (A) Grasserie
Grasserie is a highly contagious and devastating disease caused by the Nuclear Polyhedrosis Virus. It is one of the most common ailments affecting mulberry silkworms, particularly during the later larval stages. The virus invades various tissues, leading to a massive buildup of polyhedral bodies within the larval body. If not managed properly, grasserie can lead to the rapid collapse of an entire rearing batch.

114. (C) Swelling of intersegmental membranes.
As grasserie disease progresses, the silkworm larva exhibits distinct physical symptoms. The internal accumulation of viral polyhedra causes the body to become bloated and the intersegmental membranes to swell significantly. This gives the larva a shiny, distended appearance. In the final stages, the skin becomes very fragile and ruptures easily, releasing a milky white fluid that is highly infectious to other larvae in the tray.

115. (A) P-3, Q-1, R-4, S-2
Different silkworm diseases are caused by various pathogens, each requiring specific management. Grasserie is viral, while flacherie can be caused by bacteria or viruses. White muscardine is a fungal infection, and pebrine is caused by a protozoan parasite. Understanding these causative agents is essential for developing effective prevention and control strategies, such as the use of specific bed disinfectants and rigorous hygiene protocols.

116. (D) Excretion of soft, wet feces.
Bacterial flacherie is a common digestive disorder in silkworms that often results from poor environmental conditions or low-quality food. A primary symptom of this infection is the excretion of soft, wet, or chain-like feces, which is a sign of severe intestinal disruption. The affected larvae become sluggish and stop feeding, eventually dying and decomposing rapidly. Proper hygiene and leaf quality are vital for preventing this disease.

117. (B) Poor climate and leaf quality.
Flacherie in silkworms is often a complex disease triggered by physiological stress. Exposure to high temperatures and humidity, combined with the feeding of poor-quality or fermented mulberry leaves, predisposes the larvae to infection. These adverse factors weaken the silkworm's digestive system, making it vulnerable to bacterial and viral pathogens. Maintaining a clean environment and providing nutritious food are the best ways to prevent flacherie outbreaks.

118. (C) Systematic identification and removal of affected larvae from the rearing bed.
To contain an outbreak of grasserie, immediate and systematic action is required. Farmers must carefully inspect the rearing beds and remove any larvae showing signs of swelling or skin fragility. These infected individuals must be disposed of properly to prevent the milky, virus-laden fluid from contaminating the rearing environment. This manual removal, combined with the use of bed disinfectants, is essential for stopping the spread.

119. (D) Clear head disease (Touming)
Infectious flacherie is a viral disease that severely affects the silkworm's digestive tract. One characteristic symptom is that the foregut and midgut become empty of food, causing the head and thorax regions to appear translucent or clear. This phenomenon has led to the disease being colloquially called "clear head disease." This condition indicates a complete cessation of feeding and is usually followed by larval mortality.

120. (B) I, III and IV
White muscardine is a significant fungal disease caused by Beauveria bassiana. It thrives in cool, humid conditions rather than dry ones. The fungus penetrates the larval skin, leading to a mummified and hardened state after death. Eventually, the body becomes covered in a white layer of spores. Using effective bed disinfectants is a standard practice for preventing the spread of these infectious fungal spores.

121. (B) Fungal
The term "calcino" is historically significant in sericulture, used to describe the appearance of silkworms that have died from fungal infections like muscardine. After death, the body of the larva hardens and becomes chalky or stone-like due to the growth of fungal mycelia. This mummified state is a classic diagnostic feature of fungal diseases, which have been a major challenge for silk producers for centuries.

122. (B) Horizontal and vertical transmission.
Pebrine is particularly dangerous because it can be spread in two ways. Vertical transmission occurs when the protozoan parasite is passed from the mother moth to her eggs, infecting the next generation from the start. Horizontal transmission happens when larvae consume contaminated food or come into contact with infected waste. This dual mode of spread makes pebrine extremely difficult to eradicate without rigorous testing and hygiene.

123. (A) Nosema bombycis
Microscopic examination is the definitive way to diagnose pebrine disease. The causative agent,

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Nosema bombycis, produces characteristic oval-shaped spores that are highly refractile when viewed under a phase-contrast microscope. Detecting these spores in the tissues of the mother moth or in the silkworm larvae is a clear indication of infection. This diagnostic tool is the cornerstone of disease-free silkworm seed production.

124. (C) Pebrine
In the nineteenth century, the European silk industry was nearly destroyed by a widespread outbreak of pebrine. Louis Pasteur was commissioned to study the disease and subsequently developed a practical method for its control. His technique, which involves the microscopic examination of individual mother moths to ensure they are healthy before their eggs are kept, saved the industry and remains a fundamental practice in sericulture today.

125. (D) To act as a slow-release fumigant.
Managing muscardine disease often requires the use of chemical disinfectants within the rearing bed. Formalin chaff, which consists of paddy husk or sawdust soaked in a formalin solution, is spread over the larvae. It acts as a slow-release fumigant, releasing formaldehyde gas that kills the fungal spores without harming the silkworms. this technique is an effective way to maintain a sterile environment during the rearing process.

126. (C) Black pepper-like spots on the body.
The name "pebrine" is derived from the French word for pepper, referring to the characteristic black spots that often appear on the skin of infected silkworm larvae. These spots are caused by the destruction of the hypodermal cells by the protozoan parasite. While not always present in all cases, these pepper-like marks are a classic visual indicator of a severe and advanced pebrine infection in the batch.

127. (B) Endoparasitoid
The Uzi fly is a specialized pest that lives inside the body of the silkworm during its larval stage. This makes it an endoparasitoid, meaning it eventually kills its host as a natural part of its development. The fly's maggot feeds on the internal tissues of the silkworm, leading to significant damage and death, which makes the Uzi fly a major threat to the productivity of the silk industry.

128. (D) By laying eggs directly on the integument of late-instar larvae
The Uzi fly begins its attack by depositing its tiny, white, oval eggs on the skin of late-instar silkworm larvae. Once the eggs hatch, the young maggots immediately bore through the integument and enter the body of the silkworm. This direct infestation is the primary way the parasite enters its host, where it will then feed and grow at the expense of the developing silkworm.

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129. (A) A prominent black scar
When an Uzi fly maggot penetrates the silkworm's skin, it leaves a permanent mark at the site of entry. This mark develops into a prominent black scar, which is a clear diagnostic sign of infestation. Farmers can use these scars to identify infested larvae in the rearing bed. These scars result from the silkworm's immune response and the physical damage caused by the maggot as it bores inward.

130. (A) III and V
The Uzi fly's maggot feeds internally, but once it matures, it emerges from the silkworm or the cocoon to pupate in external crevices or soil. It does not pupate inside the host. Furthermore, Uzi fly populations typically peak during warmer months rather than winter freezes. Mechanical measures like wire mesh on doors are highly effective at preventing these adult flies from entering the rearing area.

131. (A) It is a hyperparasitoid that attacks the Uzi fly pupae.
Integrated pest management for Uzi flies includes the use of biological control agents. Nesolynx thymus is a tiny wasp that acts as a hyperparasitoid by laying its own eggs inside the puparia of the Uzi fly. The wasp larvae then consume the developing fly pupa. Releasing these wasps in and around rearing houses is an effective and environmentally friendly way to reduce the local population of Uzi flies.

132. (D) Prevent Uzi fly egg hatching.
Uzicide is a specialized chemical formulation developed to protect silkworms from parasitic infestation. When applied to the body of the silkworm larvae, it works by killing the eggs of the Uzi fly before they can hatch. By preventing the maggots from ever entering the silkworm's body, Uzicide provides a crucial layer of defense,

structure called a cellule. This keeps her in a confined space on an egg-laying card. The cellule ensures that she lays her eggs in a concentrated area, which facilitates easier egg collection, mother moth examination, and subsequent surface sterilization of the eggs.

96. (D) Light intensity (maintained in dim light/ darkness)
To ensure that female silkworm moths lay their eggs in a uniform and orderly manner, the environment in the oviposition room must be carefully controlled. Maintaining the room in dim light or complete darkness is essential, as bright light can disturb the moths and cause them to lay eggs irregularly or fly away. Darkness encourages the moths to remain calm and focused on laying eggs.

97. (A) Egg surface sterilization
After silkworm eggs are laid, they undergo several processing steps to ensure they are healthy and free from pathogens. Washing the eggs is a key part of surface sterilization, which removes dirt, meconium, and potentially unfertilized or dead eggs. This process, often combined with chemical treatments, ensures that the eggs remain clean and viable during the incubation period and subsequent transport to farmers.

98. (C) They can be cold-stored and reused.
In commercial grainages, male silkworm moths are valuable genetic resources. After their first mating, they can be carefully stored at low temperatures to slow down their metabolism. This allows them to be reused for a second or even third coupling if there is a shortage of males. Reusing healthy males helps in optimizing the production of disease-free layings and reduces the overall costs.

99. (A) Artificial termination of diapause.
Bivoltine silkworm eggs naturally enter a state of diapause shortly after being laid, which prevents them from hatching immediately. To allow for continuous rearing, sericulturists use hydrochloric acid to artificially terminate this dormancy. This acid treatment triggers physiological changes in the embryo that allow it to resume development. This technique is essential for synchronizing the hatching of eggs with the availability of mulberry leaves.

100. (A) IV, III, I, II
The cold acid treatment for breaking silkworm egg diapause follows a strict protocol. First, freshly laid eggs are allowed to rest for about twenty to twenty-four hours. They are then dipped in a hydrochloric acid solution at a specific temperature. Afterward, the eggs must be washed thoroughly in running water to remove any acid residue and finally dried in the shade before incubation begins.

101. (B) To synchronize brushing schedules.
Cold storage of silkworm eggs is a vital management tool used to control the timing of hatching. By keeping the eggs at low temperatures, their metabolic activity is slowed down, effectively pausing their development. This allow grainages to accumulate eggs from different batches and release them simultaneously. Synchronized hatching is essential for large-scale rearing, as it allows farmers to manage their crops and resources more efficiently.

102. (C) They will die due to nutrient depletion.
Bivoltine silkworm eggs are genetically programmed to undergo diapause, during which their metabolic rate is greatly reduced to conserve energy. If these eggs are kept at room temperature without appropriate hibernation or acid treatment, their metabolism remains too high. This leads to the rapid depletion of the limited yolk reserves stored within the egg, eventually causing the embryo to die before it can hatch.

103. (D) 46°C
Hot acid treatment is a rapid method used to break the diapause of bivoltine silkworm eggs. In this procedure, the eggs are immersed in a hydrochloric acid solution maintained at a precise temperature of forty-six degrees Celsius. This specific heat, combined with the action of the acid, effectively triggers the resumption of embryonic development. Careful monitoring of the temperature is critical to avoid damaging the delicate eggs.

104. (A) Temperature lowering and high humidity.
Hibernation is a controlled process used to overwinter silkworm eggs, ensuring they remain viable for the next season. The schedule involves a gradual lowering of temperature to maintain a state of dormancy and high humidity to prevent the eggs from drying out. These conditions mimic

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142. (C) Application after moult.
The timing of bed disinfectant application is critical for its effectiveness. Products like Vijetha are typically applied after the larvae have completed a moult and are ready to resume feeding. This ensures that the disinfectants target any pathogens present in the bed before fresh mulberry leaves are provided. Applying these powders after moult helps in maintaining a sterile environment during the highly sensitive growth periods of the larvae.

143. (B) 2.0%
Formalin is a powerful and commonly used disinfectant for sanitizing rearing houses and equipment. A two percent aqueous solution of formaldehyde is the standard concentration recommended for general disinfection. This strength is effective at killing a wide range of pathogens while being manageable for farmers. Proper application involves spraying the solution and keeping the room closed to allow the fumes to sterilize all surfaces and crevices.

144. (D) Slaked lime (Calcium hydroxide)
Bleaching powder is an effective disinfectant, but its efficacy can be enhanced by combining it with other substances. Slaked lime, or calcium hydroxide, is often mixed with bleaching powder to create a paste or solution used for sanitizing floors and trays. This mixture helps in stabilizing the chlorine and provides a long-lasting disinfecting effect. It is a standard hygiene practice in sericulture to maintain a clean rearing environment.

145. (A) P-3, Q-4, R-2, S-1
Maintaining hygiene in sericulture involves multiple products and practices. Bleaching powder is used for total room sanitation, while paraffin paper helps maintain humidity in chawki beds. Vijetha is a key disinfectant for the rearing bed itself to prevent the spread of diseases among the larvae. Furthermore, hand washing by farmers is essential to prevent the manual transfer of harmful pathogens to the delicate silkworm crop.

146. (C) The room must be perfectly airtight.
Fumigation is a process that relies on the buildup of toxic gases to kill pathogens in a confined space. For this to be effective, the rearing house must be made perfectly airtight by sealing all windows, doors, and vents. If the gas escapes, the concentration will not reach the levels needed for complete sterilization. Ensuring a properly sealed room is the most critical step for successful chemical fumigation.

147. (A) UV radiation acts as a sterilant.
Sun drying is a simple and effective traditional method for sanitizing bamboo rearing appliances. The ultraviolet radiation from direct sunlight acts as a natural sterilant, killing many of the surface-level bacteria and fungal spores that can cause silkworm diseases. Regular exposure to the sun helps maintain the hygiene of the appliances and reduces the need for heavy chemical treatments between different rearing cycles.

148. (B) 5th or 6th day
Under standard tropical conditions, bivoltine cocoons are generally ready for harvest on the fifth or sixth day after the larvae begin spinning. At this point, the transformation from a prepupa to a pupa is complete, and the cocoon shell has fully hardened. Harvesting at this time ensures that the pupa is stable and the silk quality is at its peak for subsequent processing in the filature.

149. (B) The prepupa ruptures, staining the cocoon.
If silkworm cocoons are harvested too early, such as on the second day of spinning, the larvae are still in the delicate prepupal stage. During this time, their bodies are very soft and fragile. The mechanical stress of harvesting can easily cause the prepupa to rupture, releasing internal fluids that permanently stain the silk. These stained cocoons are considered defective and lose significant value in the commercial market.

150. (C) $\frac{\text{Weight of cocoon shell}}{\text{Weight of whole cocoon}} \times 100$
The shell ratio is a fundamental quality metric used to evaluate the commercial value of silkworm cocoons. It is calculated by dividing the weight of the empty silk shell by the total weight of the whole cocoon, including the pupa inside. A higher shell ratio indicates a greater proportion of silk, which is a desirable trait in breeding and an important factor for determining cocoon prices.

151. (D) The weight in kilograms of fresh cocoons required to produce 1 kilogram of raw silk
Renditta is a critical economic parameter in the silk reeling industry that measures the efficiency of silk production. It represents the weight of fresh cocoons needed to produce exactly one

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kilogram of raw silk. This value is influenced by cocoon quality, shell ratio, and reeling efficiency. A lower renditta is always preferred by reelers, as it signifies a higher recovery of silk from the cocoons.

152. (A) Superior cocoon quality and higher silk yield
In the commercial silk trade, a lower renditta value is a direct indicator of high-quality cocoons. It means that fewer kilograms of raw material are needed to produce a kilogram of finished silk, which translates to better efficiency and higher profits for the reeler. High shell ratios and long, continuous filaments contribute to lower renditta, making these traits highly sought after in commercial silkworm breeds.

153. (B) To kill the pupa.
Stifling is an essential post-harvest process where the pupae inside the cocoons are killed before they can complete their metamorphosis into moths. If the moths were allowed to emerge, they would pierce the cocoon shell and break the continuous silk filament, making it impossible to reel. Stifling ensures that the integrity of the silk thread is maintained for industrial processing into high-quality yarn.

154. (B) Hot air stifling.
Hot air stifling is widely considered the most advanced and reliable method for processing cocoons in modern industrial filatures. This technique involves passing cocoons through a conveyor system exposed to carefully controlled hot air. Not only does it effectively kill the pupae, but it also dries the cocoons uniformly, which improves their storage life and enhances the efficiency of the subsequent silk reeling and cooking processes.

155. (A) Bangalore (Bengaluru)
The Central Silk Board is the apex national body responsible for the development of the silk industry in India. Established as a statutory organization under the Ministry of Textiles, it is headquartered in the city of Bangalore. This central location allows for the effective coordination of research, training, and policy implementation across the various silk-producing states of the country, supporting both mulberry and non-mulberry sectors.

156. (C) Mysore
The Central Sericultural Research and Training Institute, located in Mysore, is the premier research center for mulberry sericulture in southern India. It has played a pivotal role in developing high-yield mulberry varieties and productive bivoltine hybrids suited for tropical climates. The institute also serves as a major hub for training farmers and scientists, contributing significantly to the modernization of the Indian silk industry.

157. (D) CMERTI, Lahdoigarh (Jorhat)
The Central Muga Eri Research and Training Institute is specifically mandated to conduct comprehensive research on muga and eri silkworms. Located in Lahdoigarh, near Jorhat in Assam, it focuses on improving the productivity and quality of these unique non-mulberry silks. The institute's work is critical for sustaining the livelihoods of thousands of people in Northeast India who depend on these traditional and culturally significant silk varieties.

158. (C) Japan International Cooperation Agency (JICA)
The development and widespread adoption of bivoltine sericulture technology in India were greatly accelerated through a long-term collaboration with the Japan International Cooperation Agency. This partnership provided Indian scientists with access to Japanese expertise in silkworm breeding, disease control, and advanced reeling techniques. The resulting improvements in silk quality and yield helped India become a more competitive player in the global high-quality silk market.

159. (B) Extension and direct farmer assistance.
In the Indian sericulture organizational framework, the State Sericulture Departments are primarily responsible for extension activities. They work directly at the grassroots level, providing farmers with technical guidance, distributing disease-free silkworm seeds, and implementing government subsidy schemes. These departments play a vital role in ensuring that the latest research and technologies from central institutes are effectively adopted by rural silk producers in each state.

160. (D) Setting standards for seed production.
The Silkworm Seed Technology Laboratory is a specialized institution under the Central Silk

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Board that focuses on the scientific aspects of silkworm egg production. Its primary mission is to establish and maintain rigorous quality standards for grainage operations across the country. By developing better methods for egg preservation and disease detection, the laboratory ensures that farmers receive high-quality, disease-free seeds for their silk crops.

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CHAPTER 17
Lac Insect

2001

1. The lac insect, Kerria lacca, belongs to which of the following taxonomic families?
(A) Kerriidae
(B) Coccidae
(C) Pseudococcidae
(D) Margarodidae

2010

2. Which component constitutes the highest percentage by weight in the typical chemical composition of raw lac?
(A) Lac wax
(B) Laccaic acid
(C) Lac resin
(D) Shellac

2025

3. Identify the correct morphological characteristic of adult female lac insects.
(A) They are degenerate, apterous, and essentially sac-like.
(B) They possess fully developed wings and compound eyes.
(C) They exhibit distinct body segments and elongated legs.
(D) They undergo a complex pupal stage similar to males.

2009

4. From which specific anatomical structures do the nymphs and adult females secrete the lac resin?
(A) Malpighian tubules involved in waste excretion
(B) Salivary glands located near the mouthparts
(C) Anal tubercles used for honeydew excretion
(D) Specialized dermal glands found on the body

2013

5. The following question consists of two statements — Assertion (A) and Reason (R). Answer the question by selecting the appropriate option.
Assertion (A): The male lac insect does not contribute directly to the commercial yield of lac.
Reason (R): The male lac insect lacks dermal resin glands entirely during its adult stage and primarily functions for reproduction.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

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2022

6. Which of the following environmental cues is most strongly associated with the initiation of swarming behavior in lac crawlers?
(A) Decreased relative humidity levels below 30%.
(B) Depletion of nitrogen content in host plant sap.
(C) Optimal temperature ranges and host plant flush.
(D) Complete defoliation of the primary host tree.

2018

7. What is the primary characteristic that differentiates the Kusmi strain of lac from the Rangeeni strain?
(A) Exclusive reliance on Butea monosperma as a host.
(B) Completion of three distinct life cycles per year.
(C) Production of exclusively wingless male insects.
(D) Lighter-colored and higher-quality resin production.

2005

8. The Baisakhi crop of the Rangeeni strain typically undergoes swarming during which time period?
(A) June to July
(B) October to November
(C) January to February
(D) April to May

2016

9. Identify the INCORRECT statement regarding the Aghani crop of the Kusmi strain.
(A) It is inoculated in the months of June or July.

(B) It constitutes the summer crop of the Kusmi strain.
(C) It is typically harvested in January or February.
(D) Schleichera oleosa is a major host plant for this crop.

2008

10. Which of the following host trees is most suitable for cultivating the Kusmi strain of the lac insect?
(A) Butea monosperma
(B) Schleichera oleosa
(C) Ziziphus mauritiana
(D) Acacia nilotica

2021

11. Flemingia semialata is increasingly adopted in modern intensive lac cultivation primarily because of which advantage?
(A) Bushy, fast-growing plant suitable for high-density planting.
(B) Massive, slow-growing tree supporting many broodlac bundles.
(C) Natural plant that repels known hymenopteran parasitoids.
(D) Specific species that eliminates the need for any pruning.

2004

12. What is the main physiological objective of systematically pruning lac host trees prior to inoculation?
(A) To decrease total sap flow and prevent insect drowning.
(B) To permanently stunt the vertical growth of the tree.
(C) To induce succulent shoots that crawlers easily pierce.
(D) To reduce the tannin content within the older branches.

2024

13. Which agronomic practice is most essential for maintaining optimal canopy architecture in a mature Schleichera oleosa lac plantation?
(A) Annual clear-felling of the tree's main trunk.
(B) Deep plowing within the host plant's root zone.
(C) Defoliation using specific chemical desiccants.
(D) Selective pruning to form a rounded tree crown.

2018

14. Which parameter is considered least relevant when selecting and grading high-quality broodlac for field inoculation?
(A) Freedom from visual signs of predator damage
(B) High density of healthy female cells
(C) Color of the host plant bark attached to the stick
(D) Evidence of imminent crawler emergence

2012

15. Match the following lac processing stages with their corresponding characteristics.
List I: (Processing Stages)
P. Sticklac
Q. Seedlac
R. Shellac
S. Button lac
List II: (Characteristics)
1. Washed and crushed granular lac
2. Raw scraped lac containing bark and impurities
3. Melted lac formed into circular disks
4. Refined lac stretched into thin sheets
(A) P-2, Q-1, R-4, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-2, Q-4, R-1, S-3
(D) P-3, Q-1, R-2, S-4

2009

16. What is the recommended timing for the removal of phunki (empty broodlac) after inoculation to minimize pest transfer?
(A) Within 2 to 3 days of inoculation.
(B) After a duration of exactly 3 months.
(C) After the new crop has completed its first molt.
(D) 21 days or when crawler emergence ceases.

2002

17. In a systematic lac cropping system, why is a "resting period" incorporated for the host trees?
(A) To permit the tree to recover lost vigor and generate new flush
(B) To allow the lac insects to pupate in the soil
(C) To synchronize the swarming with the dry season
(D) To naturally eliminate predatory moths from the ecosystem

2007

18. Ari harvesting refers to the cutting of lac crop at which physiological stage?
(A) Fully mature stage after crawlers have emerged
(B) Post-pupal stage of the male insect only
(C) Immature stage before crawler emergence
(D) Dormant stage during intense winter

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2008

19. Seedlac is processed into shellac primarily through which of the following mechanical or thermal techniques?
(A) Melting by heat or solvent extraction.
(B) Centrifugation in large cold water tanks.
(C) Fermentation with specific types of yeast.
(D) Freeze-drying under a controlled vacuum.

2016

20. Eublemma amabilis is categorized as a major threat to lac cultivation because it acts as a:
(A) Primary parasitoid of the lac insect egg.
(B) Sap-sucking bug competing for nutrients.
(C) Fungal pathogen causing severe resin rot.
(D) Lepidopteran predator of insects and resin.

2013

21. Which hymenopteran parasitoid is widely recognized for causing significant mortality in lac insect populations?
(A) Trichogramma chilonis
(B) Tetrastichus purpureus
(C) Bracon greeni
(D) Eretmocerus eremicus

2022

22. Enclosing broodlac bundles in 60-mesh synthetic netting during inoculation serves which primary purpose?
(A) Preventing the escape of the lac crawlers.
(B) Increasing humidity for optimal egg hatching.
(C) Trapping pests while letting crawlers exit.
(D) Protecting the broodlac from UV radiation.

2010

23. Which insecticide is typically considered relatively safe for the lac insect while effective against its lepidopteran predators?
(A) Chlorpyrifos
(B) Dimethoate
(C) Monocrotophos
(D) Indoxacarb

2015

24. Bracon greeni is utilized in lac integrated pest management (IPM) as a biological control agent primarily targeting:
(A) Eublemma amabilis larvae
(B) Tetrastichus purpureus
(C) Adult Kerria lacca
(D) Weed species around the host tree

2007

25. Consider the following statements regarding the taxonomy and distribution of Kerria lacca:
I. It belongs to the order Hemiptera.
II. It is native strictly to temperate regions of Europe.
III. It falls under the superfamily Coccoidea.
Which of the above statements are correct?
(A) I and II
(B) I and III
(C) II and III
(D) III only

2011

26. The water-soluble dye extracted during the processing of raw lac is primarily composed of:
(A) Carminic acid
(B) Laccaic acid
(C) Erythrolaccin
(D) Shellolic acid

2001

27. Identify the accurate morphological distinction between adult male and female lac insects.
(A) Females feed as adults, whereas males do not.
(B) Females have antennae, whereas males have none.
(C) Females lack legs, while males retain them.
(D) Females lack wings, while males may have them.

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2004

28. The biochemical pathway for lac resin synthesis in Kerria lacca is most closely associated with the metabolism of which dietary component?
(A) Host plant structural lignin
(B) Atmospheric nitrogen
(C) Host plant phloem sap carbohydrates
(D) Cuticular waxes from the host bark

2003

29. Which life-cycle stage of Kerria lacca is solely responsible for host plant colonization and dispersion?
(A) Second nymphal instar
(B) Adult apterous female
(C) Winged adult male
(D) First instar nymph (crawler)

2011

30. Which specific microclimate condition severely impedes crawler settlement during the swarming phase?
(A) High humidity and moderate temperatures.
(B) Gentle breezes aiding crawler dispersal.
(C) Heavy rainfall washing crawlers away.
(D) Dappled sunlight through the tree canopy.

2017

31. Identify the INCORRECT pairing of a lac strain with its typical commercial attribute.
(A) Kusmi — Cultivated heavily on Schleichera oleosa
(B) Rangeeni — Lighter-colored, premium quality resin
(C) Rangeeni — Cultivated heavily on Butea monosperma
(D) Kusmi — Produces the Aghani and Jethwi crops

2012

32. In the Rangeeni strain, the Katki crop develops from inoculation done in which month?
(A) June to July
(B) October to November
(C) January to February
(D) April to May

2001

33. The Jethwi crop of the Kusmi strain completes its life cycle in approximately how many months?
(A) 4 to 5 months
(B) 6 to 7 months
(C) 8 to 9 months
(D) 10 to 11 months

2018

34. Which of the following is a primary characteristic that makes Butea monosperma an ideal lac host in central India?
(A) It requires highly fertile and waterlogged soil.
(B) It naturally repels major lepidopteran pests.
(C) It withstands pruning and regenerates rapidly.
(D) It secretes acidic sap that enhances dye color.

2021

35. Choose the correct sequence of the standard processing stages converting harvested lac into commercial sheet form.
(A) Seedlac → Sticklac → Shellac
(B) Sticklac → Shellac → Seedlac
(C) Sticklac → Seedlac → Shellac
(D) Shellac → Seedlac → Sticklac

2005

36. Pruning of Butea monosperma for raising the subsequent Baisakhi crop is most optimally scheduled during:
(A) October-November
(B) January-February
(C) July-August
(D) April-May

2015

37. Which agronomic intervention minimizes the "ari" (premature) mortality often observed in the Baisakhi crop during intense summer heat?
(A) Complete defoliation of the host tree prior to summer
(B) Maintaining partial leaf canopy for shade on the host tree
(C) Application of heavy nitrogenous fertilizers in May
(D) Spraying the encrustations with concentrated sulfuric acid

2002

38. The term "broodlac" specifically refers to:
(A) Processed seedlac stored for industrial use.
(B) Empty lac encrustations after swarming ends.
(C) Mature female insects ready for swarming.
(D) Immature lac scraped for commercial dyeing.

2002

39. During artificial inoculation, broodlac sticks are tied to the host plant branches. What is the standard recommended length for a typical broodlac stick?
(A) 2 to 5 cm
(B) 15 to 30 cm
(C) 50 to 75 cm
(D) 100 to 120 cm

2006

40. Scraping is a critical post-harvest operation. What is the primary purpose of this activity?
(A) Removing lac encrustation from twigs.
(B) Separating the dye from the resin.
(C) Inducing swarming in adult insects.
(D) Polishing the surface of button lac.

2016

41. A four-coupe system in lac cultivation is fundamentally a strategy for:
(A) Maximizing harvest at expense of tree health.
(B) Rotating trees and providing resting periods.
(C) Guaranteeing swarming across all host species.
(D) Eliminating the need for manual inoculation.

2022

42. Harvesting lac in the "Ari" stage directly negatively impacts the industry by:
(A) Producing resin that is insoluble in alcohol.
(B) Reducing available broodlac for next season.

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List II: (Common Names)
1. Ber
2. Kusum
3. Arhar / Pigeon pea
4. Palas

(A) P-4, Q-1, R-2, S-3
(B) P-2, Q-3, R-1, S-4
(C) P-1, Q-4, R-3, S-2
(D) P-4, Q-2, R-1, S-3

2005

66. A typical Butea monosperma host tree is conventionally rested for how long between successive lac crops to maintain sustained productivity?
(A) 3 months
(B) 6 months
(C) 12 months
(D) 3 years

2006

67. The harvest derived from the Katki crop is primarily utilized for:
(A) Serving as broodlac for the massive Baisakhi crop
(B) High-grade industrial shellac production
(C) Direct consumption as a food additive
(D) Dye extraction exclusively

2024

68. Which physical characteristic clearly distinguishes "button lac" from "shellac"?
(A) It contains 50% more wax than shellac.
(B) It is entirely soluble in water solutions.
(C) It is completely devoid of the lac dye.
(D) Thick circular disks rather than thin flakes.

2005

69. The larva of the white lac moth (Eublemma amabilis) causes damage by:
(A) Exuding toxic honeydew over the lac cells.
(B) Tunnelling and consuming insects and resin.
(C) Spinning a web over crawlers to suffocate.
(D) Defoliating the host plant branches.

2007

70. Tetrastichus purpureus parasitizes the lac insect primarily at which developmental stage?
(A) Crawler stage exclusively
(B) Mature adult male stage
(C) Early to mid-nymphal and early adult stages
(D) Free-flying swarming stage

2009

71. The application of wire-mesh baskets for broodlac inoculation is an example of:
(A) Chemical control
(B) Biological control
(C) Cultural control
(D) Mechanical control

2011

72. Which integrated pest management (IPM) practice simultaneously manages pest populations and ensures proper crop cycling?
(A) Timely removal and destruction of phunki
(B) Continuous Ari harvesting without leaving broodlac
(C) Monthly foliar sprays of broad-spectrum organophosphates
(D) Manual hand-picking of all adult chalcid wasps

2008

73. Which morphological feature is unique to the pupal stage of the male lac insect?
(A) Development of a hardened operculum
(B) Formation of a slipper-shaped test (cell)
(C) Secretion of large volumes of lac dye
(D) Loss of the anal tubercle

2012

74. From an ecological perspective, lac insects thrive best in environments characterized by:
(A) Environments with prolonged freezing.
(B) Moderate temperatures and seasonal rainfall.
(C) Regions with continuous torrential rain.
(D) Extremely dry desert-like conditions.

2010

75. Consider the following statements regarding the physiology and life cycle of the female lac insect:
I. It undergoes incomplete metamorphosis.
II. It possesses well-developed wings for mating flights.
III. It remains stationary after the first nymphal instar settles.
IV. It secretes resin continuously until death.
V. It produces exclusively male offspring.
Which of the above statements are correct?
(A) I, II and IV
(B) I, III and IV
(C) I, III, IV and V
(D) II, III and V

2018

76. The Baisakhi crop accounts for approximately what percentage of India's total Rangeeni lac production?
(A) 10-15%
(B) 30-40%
(C) 60-70%

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(B) Main trunk of the mature tree
(C) Lower surface of tender, succulent shoots
(D) Abaxial surface of the leaf lamina

2014

55. The following question consists of two statements — Assertion (A) and Reason (R). Answer the question by selecting the appropriate option.
Assertion (A): The Kusmi strain of lac is not successfully cultivated on Butea monosperma trees.
Reason (R): The nutritional profile and sap flow phenology of Butea monosperma do not support the life cycle requirements of the Kusmi strain.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2008

56. Which factor is most directly responsible for the mortality of lac insects during the intense summer phase of the Baisakhi crop?
(A) Starvation due to arrested host sap flow.
(B) Proliferation of harmful fungal pathogens.
(C) Excessive rainfall washing the encrustation.
(D) Over-parasitization by specific biocontrols.

2015

57. The inoculation of the Aghani crop typically occurs during which time period?
(A) June to July
(B) October to November
(C) January to February
(D) April to May

2022

58. Ziziphus mauritiana (Ber) is a versatile host plant because:
(A) It supports the Kusmi strain exclusively.
(B) Supports both Rangeeni and Kusmi strains.
(C) It eliminates the need for systematic pruning.
(D) It naturally synthesizes lac dye in its bark.

2010

59. The adoption of Flemingia semialata for lac cultivation necessitates which specific agronomic approach compared to traditional tree hosts?
(A) Intensive irrigation and fertilization.
(B) Wider spacing between plants in rows.
(C) Elimination of the phunki removal step.
(D) Harvesting only once every five years.

2024

60. When pruning Schleichera oleosa, branches larger than what diameter are typically left intact to avoid severe structural damage?
(A) 0.5 cm
(B) 1.5 cm
(C) 2.5 cm
(D) 10.0 cm

2014

61. Weed management in a bushy lac plantation (e.g., Flemingia) is most critical during which stage?
(A) Immediately post-harvest when dormant.
(B) Only when crawler emergence is active.
(C) Exclusively during the winter season.
(D) Early planting and post-pruning periods.

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2014

62. Which indicator signifies that broodlac is over-mature and has lost its field viability?
(A) Presence of yellow spots on the tubercle.
(B) Firm attachment to the host plant twig.
(C) Empty cells with prominent emergence holes.
(D) A deep crimson internal fluid in cells.

2019

63. Identify the INCORRECT method of placing broodlac during artificial inoculation.
(A) Longitudinal tying along the host branch
(B) Burying the broodlac in the soil at the base of the tree
(C) Lateral interlacing between adjacent branches
(D) Suspending brood bundles securely using natural fibers or synthetic threads

2014

64. What risk is associated with delaying the removal of phunki beyond the recommended 3-week period?
(A) The resin will re-liquefy and drip away.
(B) Crawlers migrate back into empty cells.
(C) The host plant will absorb residual resin.
(D) Pests migrate from broodlac to the new crop.

2012

65. Match the following host plants with their common names.
List I: (Host Plants)
P. Butea monosperma
Q. Ziziphus mauritiana
R. Schleichera oleosa
S. Cajanus cajan

(C) Increasing the population of major parasites.
(D) Forcing the host tree into total dormancy.

2024

43. Sticklac must be washed thoroughly during primary processing primarily to remove:
(A) Remove insect parts and water-soluble dye.
(B) Remove hardened shellac polymer structures.
(C) Remove chemical residues from insecticides.
(D) Remove bark tissues using acidic solutions.

2019

44. Pseudohypatopa pulverea causes economic damage to lac crops primarily by:
(A) Vectoring lethal viral diseases to the lac insect
(B) Burrowing into the host tree stem, causing fatal dieback
(C) Feeding on live and dead lac insects as well as the lac encrustation
(D) Laying eggs inside the host plant leaves

2001

45. Consider the following statements concerning chalcid parasitoids of the lac insect:
I. They belong to the order Lepidoptera.
II. Tachardiaephagus tachardiae is a prominent species.
III. They lay eggs inside the lac cell.
IV. They are beneficial insects used for biocontrol.
Which of the above statements are INCORRECT?
(A) I and II
(B) I and IV
(C) I, III and IV
(D) II and IV

2009

46. The cultural practice of burning or deep-burying the removed "phunki" serves to:
(A) Extract residual high-quality lac resin.
(B) Generate ash fertilizer for host plants.
(C) Destroy pests trapped in the empty cells.
(D) Induce swarming through specific signals.

2008

47. Which chemical insecticide is strictly contraindicated during the active crawler emergence stage due to high toxicity to Kerria lacca?
(A) Spinosad
(B) Dimethoate
(C) Ethofenprox
(D) Indoxacarb

2009

48. Trichogramma species are utilized in lac IPM specifically as:
(A) Larval predators of Tetrastichus purpureus
(B) Fungal antagonists against lac rust
(C) Pollinators for Schleichera oleosa
(D) Egg parasitoids against Eublemma amabilis

2006

49. The suborder Sternorrhyncha, which includes the lac insect, is characterized generally by:
(A) Posterior mouthparts relative to fore coxae.
(B) Biting and chewing mouthparts in all stages.
(C) Exclusively predatory feeding habits only.
(D) Presence of hardened elytra on the thorax.

2016

50. Which minor component of lac secretion imparts the characteristic plasticity required for commercial molding?
(A) Laccaic acid
(B) Odoriferous essential oils
(C) Lac wax
(D) Chitin

2012

51. What distinct external feature on the mature female lac cell indicates the location of the respiratory system?
(A) Brachial pores
(B) Anal tubercle
(C) Dorsal spine
(D) Ventral operculum

2002

52. The glandular secretion of lac hardens upon contact with the atmosphere. This biochemical hardening is fundamentally a process of:
(A) Simple crystallization of pure sucrose.
(B) Oxidation of specialized cuticular proteins.
(C) Evaporation of volatile aqueous plant sap.
(D) Polymerization of fatty acids and terpenes.

2024

53. Following fertilization, what physiological change primarily characterizes the female lac insect's development?
(A) Rapid development of functional wings.
(B) Body expansion and increased resin secretion.
(C) Cessation of all feeding activities.
(D) Migration to a new host tree branch.

2012

54. The spatial distribution of lac insect settlements on a host branch is generally most dense on the:
(A) Upper surface of older, lignified branches

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(D) 90-95%

2006

77. Which factor is the most significant disadvantage of utilizing minor host plants like Cajanus cajan for lac cultivation?
(A) The resin produced is highly toxic to humans.
(B) They grow too tall for easy harvesting.
(C) They repel the lac crawlers completely.
(D) Annual or short-lived, requiring replanting.

2011

78. When executing the pruning operation on Butea monosperma, the cut should ideally be made:
(A) Perfectly horizontal to hold water
(B) At a sharp angle leaving a small stump (approx. 2-3 cm)
(C) Flush with the main stem without leaving a stump
(D) Only on leaves, leaving all branches intact

2004

79. Canopy architecture maintenance in lac host trees is critical because:
(A) Ensuring maximum light reaches the roots.
(B) Providing succulent shoots for settlement.
(C) Preventing the trees from producing flowers.
(D) Accelerating the aging process of the tree.

2024

80. The optimal length of an internode on a new shoot selected for broodlac inoculation is generally an indicator of:
(A) Presence of high pest infestation levels.
(B) Indication of poor host plant nutrition.
(C) Indicator of high tannin accumulation.
(D) Vigorous growth and high sap suitability.

2019

81. Natural inoculation differs from artificial inoculation in that natural inoculation involves:
(A) Crawler self-dispersal to new shoots.
(B) Branch wrapping in synthetic mesh nets.
(C) Mechanical injection of insects into bark.
(D) Natural swarming during winter months.

2017

82. Which environmental condition is most detrimental to a newly inoculated lac crop during the crawler settlement phase?
(A) Mild cloud cover
(B) Moderate relative humidity
(C) Heavy, continuous monsoon showers
(D) Gentle air currents

2010

83. The practice of systematically alternating host plants (e.g., using Palas for one crop and Ber for the next) is generally intended to:
(A) Maintain insect vigor and reduce parasites.
(B) Mutate the lac insect into a new strain.
(C) Eradicate the lac insect from Palas trees.
(D) Convert Rangeeni strains into Kusmi ones.

2025

84. Which parameter dramatically decreases if lac is harvested as Ari rather than Phunki?
(A) Moisture content of the sticklac.
(B) Amount of water-soluble dye present.
(C) Physical hardness of the resin.
(D) Final volume of commercial broodlac.

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2009

85. The presence of 'sooty mold' on lac-host trees is an indirect indicator of which physiological activity?
(A) Excessive resin polymerization.
(B) Excretion of honeydew by lac insects.
(C) Heavy infestation of predatory moths.
(D) Decomposition of the host plant's bark.

2018

86. Which impurity is most targeted for removal during the conversion of sticklac to seedlac?
(A) Polymerized shellac
(B) Structural lignin from the host plant
(C) Lac dye and insect debris
(D) High-melting-point waxes

2006

87. Pseudohypatopa pulverea is particularly destructive during which phase of lac processing and storage?
(A) Shellac stored in alcohol solution.
(B) Hot-melting filtration processing.
(C) Packaging lac in wooden containers.
(D) Storage in poorly ventilated areas.

2017

88. Tachardiaephagus tachardiae belongs to which insect family?
(A) Encyrtidae
(B) Braconidae
(C) Eulophidae
(D) Trichogrammatidae

2024

89. The 60-mesh synthetic netting used in broodlac bundling has pore sizes specifically designed to:
(A) Allow adult insects to migrate out.
(B) Let crawlers pass but block pests.
(C) Block moisture but allow air flow.

(D) Prevent sunlight from degrading dye.

2017

90. Consider the following statements regarding chemical control in lac cultivation:
I. Synthetic pyrethroids are highly recommended during crawler emergence.
II. Indoxacarb is safer for lac insects compared to broad-spectrum organophosphates.
III. Fungicides are primarily used to kill Eublemma amabilis.
Which of the above statement(s) is/are INCORRECT?
(A) I and II
(B) I and III
(C) II and III
(D) II only

2008

91. The biological control agent Bracon greeni acts as a:
(A) Ectoparasitoid of lepidopteran larvae.
(B) Solitary endoparasitoid of bugs.
(C) Hyperparasitoid of other parasites.
(D) Viral vector against fungal disease.

2019

92. The taxonomic hierarchy of the lac insect places it in the order Hemiptera. What is the defining characteristic of this order?
(A) Heavily sclerotized forewings
(B) Complete metamorphosis (holometabolous)
(C) Piercing and sucking mouthparts
(D) Presence of halteres instead of hindwings

2009

93. Laccaic acid, responsible for the crimson dye in lac, belongs to which class of chemical compounds?
(A) Flavonoids
(B) Carotenoids
(C) Alkaloids
(D) Anthraquinones

2003

94. Sexual dimorphism in Kerria lacca becomes visually apparent during which developmental stage?
(A) The egg stage
(B) The first instar crawler stage
(C) The second nymphal instar stage
(D) Only upon death of the insect

2005

95. The following question consists of two statements — Assertion (A) and Reason (R). Answer the question by selecting the appropriate option.
Assertion (A): The adult female lac insect cannot relocate once it has settled as a crawler.
Reason (R): The legs and antennae of the female insect degenerate completely during the post-embryonic molts.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2015

96. What triggers the phenomenon of "swarming" in a mature lac encrustation?
(A) Drop in atmospheric carbon dioxide.
(B) Exhaustion of tree starch reserves.
(C) Vibration caused by seasonal winds.
(D) Hatching of eggs in the female cell.

2016

97. The habitat preference of the Kusmi strain is generally skewed towards:
(A) Humid forests with Kusum trees.
(B) Open and arid scrubland regions.
(C) Coastal mangrove swamp areas.
(D) High-altitude alpine ecozones.

2017

98. Which intrinsic factor limits the widespread commercial expansion of the Kusmi strain compared to the Rangeeni strain?
(A) It produces inferior dark resin.
(B) It is resistant to inoculation.
(C) Host abundance is lower than Palas.
(D) Its life cycle is too short.

2016

99. The Aghani crop is inoculated in June/July. What environmental stress factor primarily challenges the early establishment of this crop?
(A) Heavy monsoon rains washing crawlers.
(B) Severe winter frost killing settlements.
(C) Extreme summer drought desiccating trees.
(D) Leaf shedding of the evergreen Kusum.

2007

100. Match the following cropping seasons with their corresponding harvest months.
List I: (Cropping Seasons)
P. Baisakhi
Q. Katki

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R. Aghani
S. Jethwi
List II: (Harvest Months)
1. June / July
2. January / February
3. October / November
4. June / July (following year)
(A) P-1, Q-3, R-2, S-1
(B) P-4, Q-3, R-2, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

2011

101. Which morphological characteristic of a host tree most directly facilitates successful crawler settlement?
(A) Thick, deeply fissured, corky mature bark
(B) Thin-barked, tender and succulent new shoot growth
(C) Dense covering of rigid thorns and spines
(D) Broad, waxy leaf surfaces

2015

102. Intensive lac cultivation on Flemingia semialata is highly advantageous because it allows for:
(A) Total automation of the scraping process
(B) Complete elimination of the washing step in seedlac processing
(C) Cultivation of lac on agricultural lands as a plantation crop
(D) Cultivation without the need for water

2010

103. Pruning of Ziziphus mauritiana for the Katki crop is generally performed during which month?
(A) December
(B) February
(C) May
(D) August

2015

104. What is the physiological consequence of over-pruning a lac host tree?
(A) Depletes reserves, causing poor flush.
(B) Forces immediate swarming of insects.
(C) Increases resin yield by concentrating sap.
(D) Makes tree immune to lepidopteran pests.

2006

105. Consider the following statements regarding the grading of broodlac:
I. Thickly encrusted sticks are preferred.
II. Presence of excessive predator webbing lowers the grade.
III. Sticks with continuous encrustation are superior to patchy ones.
IV. The dead, empty cells should constitute at least 50% of a premium grade.
Which of the above statement(s) is/are correct?
(A) I and II
(B) I, II and III
(C) II, III and IV
(D) I and IV

NODIA

2008

106. During the tying of broodlac bundles, keeping the sticks in intimate contact with the host branch is crucial to:
(A) Prevent the broodlac from drying out.
(B) Ensures direct crawler path to shoots.
(C) Transfer resin directly into the tree.
(D) Eliminate hidden pest populations.

2015

107. The scraping of phunki should optimally be done immediately after its removal from the tree in order to:
(A) Prevent resin bonding to dry wood.
(B) Maximize extraction of female bodies.
(C) Allow crawlers to feed on the bark.
(D) Induce fermentation of the lac dye.

2014

108. Systematic resting of the host tree prevents which long-term negative outcome in a lac orchard?
(A) Prevents genetic drift of the insects.
(B) Prevents soil chemical accumulation.
(C) Prevents tree exhaustion and dieback.
(D) Prevents transition between strains.

2003

109. Which economic disadvantage is strongly linked to Ari harvesting?
(A) The extracted dye is colorless.
(B) Produces excess unsellable lac.
(C) Permanently sterilizes the tree.
(D) Depletes local broodlac supply.

2003

110. Choose the correct sequence of interventions to manage a heavy infestation of Eublemma amabilis in a growing lac crop.
(A) Apply broad-spectrum pyrethroid → Release Bracon greeni → Harvest early
(B) Monitor pest levels → Enclose brood in 60-mesh net during inoculation → Spray safe insecticide (e.g., indoxacarb) if damage exceeds threshold
(C) Release Trichogramma immediately → Apply heavy fungicides → Defoliate the tree
(D) Harvest Ari → Burn the tree canopy → Re-inoculate artificially

2003

153. A lac cultivator notices heavy swarming in late October. Which crop is most likely initiating its cycle?
(A) Katki
(B) Baisakhi
(C) Aghani
(D) Jethwi

2006

154. If a farmer wishes to cultivate the Aghani crop, which host tree should be primarily prepared and pruned?
(A) Butea monosperma
(B) Schleichera oleosa
(C) Cajanus cajan
(D) Ficus religiosa

2014

155. Consider the following statements regarding minor and alternative lac host plants:
I. They are crucial for bridging broodlac shortages during adverse seasons.
II. Flemingia semialata can be propagated easily through seeds.
III. Minor hosts usually yield heavily on a single plant basis compared to Kusum.
IV. Their use reduces the spatial footprint required for intensive cultivation.
V. They are susceptible to all known lac predators.
Which of the above statements are correct?
(A) I, II and IV
(B) I, III and V
(C) II, IV and V
(D) I, II and III

2024

156. The physiological response of a host tree to proper pruning includes the breakdown of apical dominance. This results directly in:
(A) The immediate death of the lateral buds.
(B) The thickening of the main trunk bark.
(C) Stimulation of fresh succulent lateral shoots.
(D) A permanent cessation of flower growth.

2019

157. Which practice demonstrates POOR agronomic management in a lac plantation?
(A) Applying balanced NPK fertilizers to trees.
(B) Slashing weeds to reduce humidity levels.
(C) Selecting pest-free broodlac for cycles.
(D) Re-inoculating without resting the branches.

2023

158. The quality of broodlac is rapidly compromised post-harvest if it is subjected to:
(A) Kept in well-ventilated and shaded areas.
(B) Tied to the host tree within 24 hours.
(C) Storage in deep piles or unventilated bags.
(D) Kept away from any direct rain falling.

2024

159. When executing artificial inoculation, what is the recommended orientation of the broodlac stick on the host branch?
(A) Perpendicular to the branch at one point.
(B) Tied parallel and firmly to the host shoot.
(C) Hanging loosely by a single thin thread.
(D) Buried partially within the bark.

2024

160. Which operation is specifically defined as the physical separation of the raw lac encrustation from the harvested host plant twigs?
(A) Inoculation
(B) Pruning
(C) Washing
(D) Scraping

****

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(C) They are ejected as honeydew.
(D) They immediately kill the female insect.

2025

122. Which geographic region in India is historically the most prominent hub for both cultivation and primary processing of lac?
(A) The coastal plains of Kerala
(B) The Chotanagpur plateau (Jharkhand and surrounding areas)
(C) The arid deserts of Rajasthan
(D) The alpine valleys of Himachal Pradesh

2012

123. The Rangeeni strain is so named primarily because:
(A) Produces darker, dye-rich resin.
(B) Feeds strictly on Rangeeni grass.
(C) Discovered in the Rangoon region.
(D) Adults are brightly multicolored.

2019

124. The duration of the Baisakhi crop is unusually long (about 8-9 months) primarily due to:
(A) Genetically programmed nymphal stage.
(B) Parasitoid attacks slowing growth.
(C) Winter cold and delayed summer sap flush.
(D) Continuous molting of the females.

2025

125. Match the following pest control methods with their specific application in lac cultivation.
List I: (Pest Control Methods)
P. 60-mesh synthetic netting
Q. Indoxacarb spraying
R. Bracon greeni release
S. Phunki removal
List II: (Application)
1. Biological control
2. Cultural control
3. Mechanical control
4. Chemical control
(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-2, Q-1, R-4, S-3
(D) P-1, Q-2, R-3, S-4

2024

126. The Jethwi crop typically exhibits swarming during which period?
(A) June to July
(B) October to November
(C) January to February
(D) April to May

2015

127. Which morphological feature of Ziziphus mauritiana makes inoculation operations slightly more labor-intensive compared to Butea monosperma?
(A) Its extremely smooth, slippery bark.
(B) Sharp stipular spines on branches.
(C) The continuous shedding of its bark.
(D) Its massive trunk diameter size.

2005

128. Why is Flemingia semialata usually planted under irrigated conditions or in regions with assured moisture for optimal lac production?
(A) The lac insects require free water.
(B) Flooding is necessary to kill pests.
(C) Roots must be submerged for resin.
(D) To maintain high host plant vigor under the heavy stress of lac encrustation.

NODIA

2006

129. When pruning a heavy branch of a Kusum tree, a step-cut is highly recommended to:
(A) Prevent bark tearing on the main trunk.
(B) Maximize surface area for resin attachment.
(C) Encourage the growth of fungal symbionts.
(D) Trap the falling crawlers during swarm.

2002

130. Consider the following statements concerning the agronomic management of lac host plantations:
I. Standard fertilizer application enhances shoot vigor and subsequent lac yield.
II. High-density planting is suitable for bushy hosts like Flemingia.
III. Total defoliation is required monthly to ensure sunlight reaches the insects.
Which of the above statement(s) is/are correct?
(A) I and II
(B) I and III
(C) II and III
(D) III only

2007

131. Broodlac should ideally be harvested:
(A) Approximately 1 to 2 weeks prior to the anticipated swarming
(B) Exactly 2 months before the expected swarming date
(C) Only when the crawlers have fully emerged and left the cells
(D) During the heaviest monsoon rains

2004

132. The visual "yellow spot" appearance on a mature female lac cell indicates:

from the mother cell and crawl along branches to find suitable, succulent spots for settlement. Once they insert their mouthparts and settle, they become sedentary for the remainder of their lives.

30. (C) Heavy rainfall washing crawlers away.
The settlement phase of the first instar nymphs is a highly vulnerable period in the lac life cycle. Extreme weather conditions, particularly heavy and continuous rainfall, can physically wash the tiny crawlers off the host branches before they have a chance to settle and start feeding. This leads to high mortality rates and can result in total crop failure during inoculation.

31. (B) Rangeeni — Lighter-colored, premium quality resin
The statement pairing the Rangeeni strain with lighter-colored, premium quality resin is incorrect. In reality, it is the Kusmi strain that is known for producing the superior, lighter-colored resin. The Rangeeni strain typically produces a darker, more dye-rich lac. Understanding these differences is essential for farmers to choose the right strain based on host availability and market demand.

32. (A) June to July
The Katki crop is the second of the two annual crops produced by the Rangeeni strain of lac insects. Inoculation for this crop is generally carried out in June or July, coinciding with the swarming of the Baisakhi crop. This crop has a shorter duration compared to the Baisakhi crop and is typically harvested in October or November.

33. (B) 6 to 7 months
The Jethwi crop belongs to the Kusmi strain and is typically inoculated in January or February. It matures over the summer months and is harvested in June or July. The total duration of this life cycle is approximately six to seven months. Proper management during this period is vital to ensure the production of high-quality Kusmi broodlac for the next season.

34. (C) It withstands pruning and regenerates rapidly.
Butea monosperma, commonly known as Palas, is a primary host for the Rangeeni strain in central India. Its major advantage is its remarkable ability to withstand heavy and systematic pruning. The tree regenerates quickly, producing numerous succulent shoots that are ideal for the settlement and feeding of lac crawlers, making it a reliable choice for sustainable lac cultivation.

35. (C) Sticklac → Seedlac → Shellac
The standard sequence for processing lac into its commercial forms begins with sticklac, which is the raw material scraped from the host tree. This is then crushed and washed to remove impurities and dye, resulting in seedlac. Finally, seedlac is melted and filtered to produce refined shellac. This progression ensures the removal of foreign matter and consistent product quality.

36. (D) April-May
To prepare Butea monosperma trees for the Baisakhi crop, pruning is most optimally scheduled during April or May. This timing allows the tree sufficient time to produce a fresh flush of succulent shoots by the time inoculation occurs in October or November. Proper scheduling of pruning is essential to synchronize the availability of suitable host tissue with the insect's life cycle.

37. (B) Maintaining partial leaf canopy for shade on the host tree.
Intense summer heat is a major cause of mortality in the Baisakhi crop. To mitigate this, cultivators are advised to maintain a partial leaf canopy on the host trees. The shade provided by the leaves helps to lower the temperature on the branches, protecting the developing lac insects from desiccation and reducing the risk of premature, or ari, mortality.

38. (C) Mature female insects ready for swarming.
Broodlac is a specialized term used in lac cultivation to describe the mature lac encrustations that contain healthy, gravid female insects ready to release their crawlers. These sticks are harvested just before swarming and used as "seed" to inoculate new host trees. The quality and timing of broodlac selection are critical factors determining the success of the subsequent crop.

39. (B) 15 to 30 cm
During the artificial inoculation process, broodlac is prepared by cutting mature encrusted twigs into specific lengths. The standard recommended length for these sticks is typically between fifteen and thirty centimeters. This size is convenient

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Integrated Pest Management (IPM) strategy for lac cultivation?
(A) Prophylactic application of toxic chemicals.
(B) Cultural controls like timely phunki removal.
(C) Deforestation of alternative host plants.
(D) Weekly release of predatory hyperparasites.

2003

144. In the taxonomy of the lac insect, what is the hierarchical position immediately above the family Kerriidae?
(A) Suborder Sternorrhyncha
(B) Order Hemiptera
(C) Class Insecta
(D) Superfamily Coccoidea

2011

145. The following question consists of two statements — Assertion (A) and Reason (R). Answer the question by selecting the appropriate option.
Assertion (A): The commercial value of shellac is significantly determined by its color.
Reason (R): Darker shellac contains higher amounts of impurities and polymerized resin, which limits its application in fine industrial finishes.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2013

146. Which structural component of the lac resin is highly valued in the cosmetics and pharmaceutical industries for its film-forming properties?
(A) Laccaic acid
(B) Chitin
(C) Aleuritic acid
(D) Anthraquinone dye

2003

147. During crawler settlement, the phenomenon of "encrustation" occurs because:
(A) Fused resin secretions of settled insects.
(B) Crawlers merging into a single super-organism.
(C) Host plant secretes a gum to trap insects.
(D) Fungal mycelia binding individual insects.

2003

148. The honeydew excreted by the lac insect is primarily composed of:
(A) Complex cuticular waxes
(B) Pure polymerized lac resin
(C) Defensive alkaloid toxins
(D) Unabsorbed plant sugars and amino acids

2014

149. Why is the male lac insect sometimes winged and sometimes apterous (wingless)?
(A) Winged forms only appear on dead host plants.
(B) Genetically polymorphic trait in populations.
(C) Only the Kusmi strain produces these males.
(D) Winglessness is caused by parasitization.

2010

150. Match the anatomical/physiological term with its definition in the lac insect.
List I: (Anatomical/Physiological Terms)
P. Anal tubercle
Q. Brachial pores
R. Operculum
S. Crawler
List II: (Definitions)
1. The mobile, first instar nymph
2. The structure bearing the respiratory openings
3. The extension through which honeydew is excreted to prevent resin contamination
4. The hardened plate covering the anal opening in male pupae
(A) P-3, Q-2, R-4, S-1
(B) P-2, Q-3, R-1, S-4
(C) P-1, Q-4, R-2, S-3
(D) P-3, Q-1, R-4, S-2

2011

151. Which factor is most critically affected when swarming crawlers are exposed to ambient temperatures exceeding 40°C?
(A) They immediately mutate into winged females.
(B) They burrow deep into the host plant xylem.
(C) They begin secreing dye instead of resin.
(D) Rapid desiccation and high crawler mortality.

2002

152. The Kusmi strain produces the highest quality lac, yet the Rangeeni strain dominates total volume production. What explains this discrepancy?
(A) Wider climate tolerance and host abundance.
(B) Microscopic insects and low resin yields.
(C) Resin is too hard to be scraped manually.
(D) It completes four life cycles in one year.

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2006

111. The commercial product "shellac" is distinct from "seedlac" because shellac is:
(A) Unwashed material scraped from trees.
(B) Melted and filtered to remove impurities.
(C) Contains the highest amount of debris.
(D) Synthesized in a commercial laboratory.

2016

112. Which statement accurately describes the feeding behavior of Pseudohypatopa pulverea?
(A) Sucks sap and deprives insects of food.
(B) Parasitizes the pupae of male insects.
(C) Feeds solely on secreted honeydew.
(D) Feeds on insects and lac encrustation.

2008

113. Parasitization by Tetrastichus purpureus can be visually diagnosed in the field by observing:
(A) Circular emergence holes on lac cells.
(B) Large gaping tunnels with silk webs.
(C) Sooty mold covering the encrustation.
(D) Complete melting of the lac resin.

2021

114. The use of biological control agents in lac cultivation requires precise timing because:
(A) Must be released during heavy monsoons.
(B) Highly sensitive to host tree sap levels.
(C) Requires synchronization with pest stages.
(D) Feeds on resin if pests are not present.

2012

115. Consider the following statements regarding the glandular system and resin secretion in Kerria lacca:
I. Resin is secreted by specialized epidermal glands.
II. Secretion begins only after the insect completes its final molt.
III. The wax filaments prevent the respiratory pores from being blocked by liquid resin.
IV. The anal tubercle secretes honeydew, not resin.
V. Male insects produce significantly more resin per capita than females.
Which of the above statement(s) is/are INCORRECT?
(A) I and III
(B) II and V
(C) II, IV and V
(D) III and IV

2003

116. Indoxacarb is integrated into lac IPM programs specifically due to its:
(A) Acts as a systemic herbicidal agent.
(B) Kills fungal pathogens on host leaves.
(C) Sterilizes the host plant bark tissue.
(D) Effective against pests, safe for lac.

2017

117. The primary reason for the decline in the global market dominance of natural shellac in the mid-20th century was:
(A) Extinction of the primary host trees.
(B) Competition with cheap synthetic resins.
(C) Loss of the premium Kusmi lac strain.
(D) Mass viral pandemics in the insect.

2016

118. Which distinctive physical trait allows field workers to distinguish between the male and female lac insect cells during the later stages of development?
(A) Male cells are green; females are crimson.
(B) Male cells have large breathing tubes.
(C) Male cells are slipper-like; females globular.
(D) Male cells found only on host leaves.

2025

119. A defining characteristic of the lac insect's respiratory system is the presence of:
(A) Extensive book lungs in the abdomen.
(B) Gills attached to the thoracic legs.
(C) Cuticular diffusion on ventral surface.
(D) Brachial tubes extending to ambient air.

2009

120. The following question consists of two statements — Assertion (A) and Reason (R). Answer the question by selecting the appropriate option.
Assertion (A): The swarming of lac crawlers is highly synchronized and usually occurs during specific hours of the day.
Reason (R): Crawlers emerge in response to specific photoperiodic and temperature cues, typically during the warmer morning hours.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

NODIA

2013

121. What happens to the unfertilized eggs in a female Kerria lacca?
(A) They are resorbed into the female's body to sustain resin production.
(B) They develop parthenogenetically into female offspring in rare strains.

ANSWERS

1. (A) Kerriidae
Kerria lacca is scientifically classified under the family Kerriidae within the superfamily Coccoidea. This family specifically includes scale insects that secrete a resinous substance known as lac. These insects are mostly found in tropical and subtropical regions. Classification helps in understanding the biological characteristics and life cycle requirements necessary for commercial production and effective management practices.

2. (C) Lac resin
Raw lac or sticklac is a complex mixture of several organic substances. The most significant component is the lac resin, which typically accounts for seventy to eighty percent of the total weight. Other constituents include lac wax, dye, and various impurities such as insect remains and vegetable matter. This high resin content determines the commercial value for industrial applications.

3. (A) They are degenerate, apterous, and essentially sac-like.
Adult female lac insects exhibit significant morphological degeneration after settling on host plants. They lose their legs, antennae, and wings, eventually becoming sedentary, sac-like organisms enclosed within a protective resinous cell. This specialized form allows them to focus entirely on feeding on plant sap and secreting the resin that forms the protective encrustation used in commercial lac production.

4. (D) Specialized dermal glands found on the body
Lac resin is a glandular secretion produced by both nymphs and adult females of the lac insect. Specialized dermal glands distributed throughout the body surface are responsible for synthesizing and secreting this resinous substance. Upon exposure to air, the liquid secretion hardens to form a protective cell around the insect, which eventually coalesces into a continuous commercial encrustation.

5. (A) Both A and R are true and R is the correct explanation of A.
Male lac insects do not contribute to the commercial yield because they lack the specialized dermal resin glands found in females. Their primary biological role is fertilization. During the adult stage, males are much smaller and do not produce the significant resinous encrustations required for harvesting. Consequently, the commercial production of lac depends almost entirely on the female population.

6. (C) Optimal temperature ranges and host plant flush.
Swarming represents the emergence of first instar nymphs from the mother cells. This behavior is strongly influenced by environmental factors, particularly temperature and humidity. Additionally, the availability of fresh, succulent growth on host plants, known as flush, provides the necessary nutritional environment for the crawlers to settle and begin their life cycle successfully. Synchronization with host phenology ensures survival.

7. (D) Lighter-colored and higher-quality resin production.
The Kusmi strain of lac insects is primarily cultivated on the Kusum tree and produces a resin that is significantly lighter in color and higher in quality compared to the Rangeeni strain. This superior resin, often referred to as Kusmi lac, is highly valued in international markets. It commands a higher price due to its purity and favorable physical properties.

8. (A) June to July
The Baisakhi crop belongs to the Rangeeni strain and is the most significant commercial crop in India. It is usually inoculated in October or November and matures over several months. The emergence of the next generation of crawlers, or swarming, typically occurs during June or July. This timing is critical for the subsequent inoculation of the Katki crop cycle.

9. (B) It constitutes the summer crop of the Kusmi strain.
The Aghani crop is actually the winter crop of the Kusmi strain, not the summer crop. It is typically inoculated in June or July and harvested during January or February of the following year. Schleichera oleosa, commonly known as the

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(A) Fungal infection of the resin layer.
(B) Synthesis of high-quality lac wax.
(C) Parasitization by a chalcid wasp.
(D) Egg movement into incubation chamber.

2008

133. Which factor primarily dictates the quantity of broodlac to be tied to a specific host tree?
(A) Age of the person doing inoculation.
(B) Surface area of suitable tender shoots.
(C) Total height of the host tree.
(D) Amount of rainfall in previous week.

2016

134. Determining the exact timing for Phunki scraping is essential because leaving the empty encrustation on the scraped sticks for too long:
(A) Reverses the polymerization of the resin.
(B) Converts the sticklac back into honeydew.
(C) Resin becomes harder to remove mechanically.
(D) Induces spontaneous combustion in storage.

2014

135. Consider the following life cycle stages of a male lac insect:
I. Adult
II. Pupa
III. Egg
IV. First instar nymph (crawler)
V. Prepupa
Which of the following represents the correct biological sequence?
(A) III, IV, II, V, I
(B) III, IV, V, II, I
(C) IV, III, V, II, I
(D) III, V, IV, II, I

2011

136. The practice of "partial harvesting" (leaving some branches untouched) in a lac tree is primarily an approach to:
(A) Facilitate natural inoculation for next crop.
(B) Improve the aesthetic shape of the tree.
(C) Test the efficacy of different insecticides.
(D) Extract only the highest quality button lac.

2001

137. Which economic product is extracted during the primary aqueous washing of crushed sticklac?
(A) Shellolic acid
(B) Lac dye
(C) Aleuritic acid
(D) Pure shellac flakes

2025

138. The addition of sodium carbonate or mild alkalis during the hot processing of seedlac is occasionally done to:
(A) Increase the mechanical hardness of the final product
(B) Bleach the shellac and remove the residual color
(C) Convert the resin into a permanent liquid
(D) Repel storage pests

2006

139. The most visible symptom of severe Eublemma amabilis infestation on a lac-bearing branch is:
(A) Silken webs with fecal frass on encrustation.
(B) Branch rapidly turning black and dying off.
(C) Disappearance of resin leaving only insects.
(D) Rapid elongation of the host plant internode.

2002

140. Consider the following statements regarding the biological control of lac pests:
I. Trichogramma species are egg parasitoids.
II. Bracon greeni targets the larval stage of the lac insect.
III. Mass rearing of biocontrol agents is a key component of lac IPM.
IV. Biocontrol completely eliminates the need for any cultural practices.
Which of the above statement(s) is/are INCORRECT?
(A) I and III
(B) II and IV
(C) I, II and IV
(D) III and IV

NODIA

2007

141. The use of insect-proof wire-mesh baskets for artificial inoculation drastically reduces the incidence of which pest?
(A) Fungal pathogens like Fusarium.
(B) Termites attacking the host trunk.
(C) Sap-sucking aphids on the leaves.
(D) Predators emerging from the broodlac.

2007

142. Spinosad is an insecticide derived from:
(A) Synthetic petroleum distillates
(B) Botanical extracts of the neem tree
(C) Fermentation products of the actinomycete Saccharopolyspora spinosa
(D) Inorganic copper compounds

2003

143. Which management practice is considered the foundational "first line of defense" in an

impurities. Alternatively, solvent extraction using alcohol can be employed to produce high-purity shellac. These techniques ensure the final product meets industrial standards for color, wax content, and solubility.

20. (D) Lepidopteran predator of insects and resin.
Eublemma amabilis, commonly known as the white lac moth, is one of the most destructive predators in lac cultivation. Its larvae tunnel through the lac encrustations, feeding on both the living lac insects and the secreted resin. This predatory activity significantly reduces the yield and quality of the lac crop, making it a primary target for pest management.

21. (B) Tetrastichus purpureus
Tetrastichus purpureus is a widespread hymenopteran parasitoid that causes significant mortality in lac insect populations. It lays its eggs within the lac cells, and the developing larvae consume the lac insect. The presence of these parasitoids is often indicated by small, circular exit holes on the surface of the resinous encrustation, signaling a reduction in the overall crop yield.

22. (C) Trapping pests while letting crawlers exit.
Using sixty-mesh synthetic netting to enclose broodlac bundles is a highly effective mechanical control measure. The mesh size is specifically chosen to allow the tiny lac crawlers to pass through and settle on host branches while simultaneously trapping larger predatory moths and parasitoids emerging from the broodlac. This technique significantly reduces the initial pest pressure on the new crop.

23. (D) Indoxacarb
In integrated pest management for lac, it is crucial to use insecticides that target lepidopteran predators without harming the lac insects themselves. Indoxacarb is a preferred choice as it is relatively safe for Kerria lacca but highly effective against pests like Eublemma amabilis. Selective chemical use helps maintain the delicate balance required for a healthy and productive lac ecosystem.

24. (A) Eublemma amabilis larvae
Bracon greeni is a beneficial ectoparasitoid used as a biological control agent in lac cultivation. It specifically targets the larvae of the predatory white lac moth, Eublemma amabilis. By laying eggs on or near the predator larvae, the emerging Bracon larvae consume the pest, thereby reducing its population and protecting the lac crop from extensive damage and yield loss.

25. (B) I and III
Kerria lacca belongs to the order Hemiptera and the superfamily Coccoidea, making statements I and III correct. It is not native to temperate Europe; instead, it is primarily found in tropical and subtropical regions of Asia, particularly India and Thailand. Understanding its correct taxonomic placement is fundamental for studying its biology, host plant interactions, and distribution patterns in agriculture.

26. (B) Laccaic acid
The crimson-colored, water-soluble dye extracted during the washing of sticklac is primarily composed of laccaic acid. This dye was historically the most valued part of the lac secretion before the widespread use of synthetic dyes. Today, it is still used as a natural coloring agent in various industries, including food and cosmetics, due to its non-toxic properties.

27. (A) Females feed as adults, whereas males do not.
A significant physiological difference between adult lac insects is that females continue to feed throughout their adult life to support resin production and egg development. In contrast, adult males have degenerate mouthparts and do not feed; their sole function is to locate and fertilize females. This difference reflects the specialized reproductive roles each gender plays within the colony.

28. (C) Host plant phloem sap carbohydrates
The synthesis of lac resin by Kerria lacca is a complex biochemical process. The insects use their piercing-sucking mouthparts to extract phloem sap from the host plant. The carbohydrates and other nutrients found in this sap are metabolized within the insect's body and converted into the resinous secretion. Consequently, the health and nutritional status of the host plant directly impact production.

29. (D) First instar nymph (crawler)
The first instar nymph, commonly known as a crawler, is the only mobile stage responsible for colonization and dispersal in the lac insect life cycle. After hatching, these tiny nymphs emerge

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Kusum tree, serves as the primary host for this high-quality lac crop, which represents a major production season.

10. (B) Schleichera oleosa
Schleichera oleosa, popularly known as the Kusum tree, is recognized as the most suitable and preferred host for the Kusmi strain of lac insects. This tree provides the specific nutritional profile and sap flow required for the production of high-quality, light-colored resin. While other trees like Ber can host Kusmi lac, Kusum remains the definitive primary host.

11. (A) Bushy, fast-growing plant suitable for high-density planting.
Flemingia semialata is a perennial shrub that has gained popularity in intensive lac cultivation. Its bushy nature and rapid growth allow for high-density planting on agricultural lands, facilitating easier management and harvesting compared to traditional large trees. This host is particularly suitable for the Kusmi strain, enabling farmers to produce high-quality lac in a more controlled, plantation-style environment.

12. (C) To induce succulent shoots than crawlers easily pierce.
Systematic pruning is a vital agronomic practice used to manage the canopy of lac host trees. The primary objective is to stimulate the growth of new, succulent shoots. These tender branches are easier for the first instar nymphs, or crawlers, to pierce with their mouthparts. This ensures successful settlement and feeding, which is essential for a productive crop.

13. (D) Selective pruning to form a rounded tree crown.
Maintaining a proper canopy architecture in mature Schleichera oleosa trees is essential for sustainable lac production. Selective pruning is employed to create a rounded crown, which maximizes the availability of suitable shoots for inoculation. This practice also ensures adequate light penetration and airflow within the canopy, reducing the incidence of pests and diseases while facilitating easier harvesting operations.

14. (C) Color of the host plant bark attached to the stick
When selecting and grading broodlac, the most critical factors are the health and density of the female cells, the absence of predator damage, and signs of imminent crawler emergence. The color of the host plant bark is largely irrelevant to the quality of the insects themselves. Focus is placed on biological indicators that ensure successful inoculation and yield.

15. (A) P-2, Q-1, R-4, S-3
Lac processing involves several distinct stages. Raw material scraped from branches is called sticklac. Once washed and crushed into granules, it becomes seedlac. Refined lac stretched into thin sheets is known as shellac, while melted lac formed into small, circular disks is referred to as button lac. This sequential refining process removes impurities and prepares the resin for industrial use.

16. (D) 21 days or when crawler emergence ceases.
After the inoculation of host trees, the empty broodlac sticks, known as phunki, must be removed promptly. This removal is usually carried out after twenty-one days or once the emergence of crawlers has completely stopped. Timely removal prevents the migration of harmful predators and parasitoids from the old broodlac to the newly settled and vulnerable lac insect population.

17. (A) To permit the tree to recover lost vigor and generate new flush
Continuous lac cultivation can significantly drain the nutrients and vitality of host trees. A mandatory resting period is incorporated into the cropping system to allow the trees to recover their physiological vigor. During this time, the trees regenerate their canopy and produce new, succulent flush, ensuring they remain healthy and productive for future lac insect inoculations.

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18. (C) Immature stage before crawler emergence
Ari harvesting refers to the practice of cutting the lac crop before the insects have reached full maturity and before the crawlers have emerged. While this provides early income, it is generally discouraged because it destroys the potential broodlac needed for the next season. It is often done in summer to prevent total loss from extreme heat-induced mortality.

19. (A) Melting by heat or solvent extraction.
The conversion of seedlac into the more refined shellac is achieved through thermal or chemical methods. In the traditional heat process, seedlac is melted and filtered through cloth bags to remove

for handling and tying securely to the host plant branches, ensuring an even distribution of emerging crawlers across the new succulent shoots of the tree.

40. (A) Removing lac encrustation from twigs.
Scraping is a fundamental post-harvest operation where the resinous lac encrustation is physically removed from the host plant twigs. This process yields sticklac, the primary raw material for further industrial processing. Effective scraping ensures maximum recovery of the resin while minimizing the amount of woody debris and bark that can contaminate the lac during the subsequent washing and refining stages.

41. (B) Rotating trees and providing resting periods.
The four-coupe system is a systematic management strategy used to ensure sustainable lac production. By dividing host trees into four groups or "coupes," cultivators can rotate the inoculation and harvesting cycle. This method guarantees that each group of trees receives an adequate resting period to recover their vigor between crops, preventing tree exhaustion and maintaining long-term plantation health.

42. (B) Reducing available broodlac for next season.
Harvesting lac in the Ari, or immature, stage has a significant negative impact on the industry because it destroys the insects before they can reproduce. This leads to a severe shortage of broodlac for the next cropping season. While it may provide immediate financial return or prevent total loss from heat, it undermines the long-term sustainability of lac cultivation.

43. (A) Remove insect parts and water-soluble dye.
Primary processing of sticklac involves thorough washing in water. The main purpose of this activity is to remove impurities such as dead insect bodies, vegetable matter, and the water-soluble lac dye. Removing these components is essential to produce seedlac, which serves as the base material for manufacturing refined shellac. Clean seedlac ensures the final product meets commercial quality standards.

44. (C) Feeding on live and dead lac insects as well as the lac encrustation
Pseudohypatopa pulverea is a major lepidopteran predator that causes extensive economic damage to lac crops. Its larvae are highly destructive, feeding on both live and dead lac insects, as well as the resinous encrustation itself. By tunneling through the crop, they compromise the integrity and volume of the lac produced, necessitating rigorous pest control measures during the cultivation process.

45. (B) I and IV
Statements I and IV are incorrect because chalcid parasitoids belong to the order Hymenoptera, not Lepidoptera, and they are generally considered pests in lac cultivation, not beneficial biocontrol agents. They cause significant mortality by laying eggs inside lac cells. In contrast, Tachardiaephagus tachardiae is a real chalcid species, and their parasitic nature is a major challenge for productive lac farming.

46. (C) Destroy pests trapped in the empty cells.
After the emergence of crawlers, the empty broodlac sticks, or phunki, often harbor residual populations of predators and parasitoids. Cultural practices such as burning or deep-burying these removed sticks are essential to destroy these trapped pests. This prevents them from emerging and re-infesting the new lac crop, thereby breaking the pest life cycle and protecting the developing insects.

47. (B) Dimethoate
Dimethoate is a broad-spectrum organophosphate insecticide that is highly toxic to lac insects. It is strictly contraindicated during the active crawler emergence and settlement stages because it can cause massive mortality in the vulnerable Kerria lacca population. Using such non-selective chemicals can lead to total crop failure, highlighting the need for specialized insecticides that target only the pests.

48. (D) Egg parasitoids against Eublemma amabilis
Trichogramma species are tiny hymenopteran wasps utilized in integrated pest management as egg parasitoids. They are released into lac plantations to specifically target and parasitize the eggs of major predators like the white lac moth, Eublemma amabilis. By preventing the predator eggs from hatching into destructive larvae, Trichogramma helps to significantly reduce crop damage and improve the overall lac yield.

49. (A) Posterior mouthparts relative to fore coxae.
The suborder Sternorrhyncha, which includes lac insects, aphids, and scale insects, is anatomically

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108. (C) Prevents tree exhaustion and dieback.
Systematic resting of host trees is a vital cultural practice designed to prevent long-term negative outcomes such as tree exhaustion and branch dieback. Constant lac cultivation places a heavy physiological burden on the tree. By providing periodic breaks, the tree can recover its vigor, replenish its sap reserves, and maintain its structural health, ensuring it remains a productive host for many years.

109. (D) Depletes local broodlac supply.
The primary economic disadvantage of Ari harvesting is the severe depletion of the local broodlac supply. Since the crop is harvested before the insects reach maturity, no crawlers are produced for the next season. This forces farmers to rely on external sources for broodlac, increasing their production costs and making the local lac industry vulnerable to shortages and price fluctuations in the market.

110. (B) Monitor pest levels → Enclose brood in 60-mesh net during inoculation → Spray safe insecticide (e.g., indoxacarb) if damage exceeds threshold
Effective management of Eublemma amabilis requires a systematic integrated approach. This begins with regular monitoring of pest levels. Mechanical control is then applied by enclosing broodlac in sixty-mesh netting to prevent initial infestation. Finally, if the predator population exceeds an economic threshold, selective and safe insecticides like indoxacarb should be used. This sequence minimizes chemical use while effectively protecting the lac crop.

111. (B) Melted and filtered to remove impurities.
Shellac is a more refined commercial product than seedlac. While seedlac is composed of washed and crushed lac granules, shellac is produced by melting seedlac and passing it through fine filters to remove any remaining impurities, such as insect remains and vegetable matter. This extra refining step results in a high-purity resin that is suitable for precision industrial and commercial coatings.

112. (D) Feeds on insects and lac encrustation
Pseudohypatopa pulverea is a highly destructive lepidopteran predator in the lac ecosystem. Its larvae feed indiscriminately on both the living lac insects and the secreted resinous encrustation. This behavior leads to the physical destruction of the crop and reduces the overall yield. Additionally, their tunnels and frass contaminate the harvested material, making the refining process more difficult and less efficient.

113. (A) Circular emergence holes on lac cells.
In the field, parasitization by the chalcid wasp Tetrastichus purpureus can be diagnosed by the presence of small, distinct, circular emergence holes on the surface of the lac cells. These holes are created when the adult parasitoid wasps exit the host cell after completing their larval development inside the lac insect. Observing these holes is a clear sign of significant population mortality.

114. (C) Requires synchronization with pest stages.
The successful use of biological control agents in lac cultivation depends heavily on precise timing. Predators and parasitoids must be released when the target pest populations are at their most vulnerable life stages. This synchronization ensures that the biocontrol agents can effectively locate and consume the pests before they cause significant damage to the developing lac insect population and resin crop.

115. (B) II and V
Statements II and V are incorrect because resin secretion begins immediately after the crawler settles, not after the final molt, and adult females produce significantly more resin than males. In fact, males produce very little resin. Conversely, specialized epidermal glands are indeed responsible for secretion, and wax filaments are vital for keeping respiratory pores clear of liquid resin as it hardens into the cell.

116. (D) Effective against pests, safe for lac.
Indoxacarb is integrated into lac integrated pest management programs because of its high degree of selectivity. It is highly effective at controlling lepidopteran predators like Eublemma amabilis and Pseudohypatopa pulverea while being relatively non-toxic to the lac insect, Kerria lacca. This selectivity allows for effective pest control without jeopardizing the survival of the primary organism responsible for resin production.

117. (B) Competition with cheap synthetic resins.
The mid-twentieth century saw a significant decline in the global market dominance of natural shellac. This was primarily due to the development and widespread availability of

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density systems, it needs regular irrigation and fertilization to maintain the high vigor necessary to support heavy lac encrustations. This intensive management ensures consistent yields and healthy plant growth in a plantation setting.

60. (C) 2.5 cm
When pruning Schleichera oleosa for lac cultivation, it is important to preserve the structural integrity of the tree. Branches with a diameter larger than approximately 2.5 centimeters are typically left intact. Cutting beyond this thickness can cause severe damage and slow down the tree's recovery. Proper pruning focuses on smaller twigs to encourage the growth of fresh, succulent shoots.

61. (D) Early planting and post-pruning periods.
In bushy lac plantations like those using Flemingia semialata, weed management is most critical during the early stages of plant establishment and immediately after pruning. Weeds compete for essential nutrients and moisture, which can weaken the host plants and reduce their ability to support a productive lac crop. Effective control during these periods ensures optimal growth and high-quality resin production.

62. (C) Empty cells with prominent emergence holes.
Broodlac is considered over-mature and no longer viable for field inoculation when the cells appear empty and show prominent emergence holes. This indicates that the crawlers have already hatched and left the mother cells, leaving no insects to colonize the new host tree. Identifying this stage is crucial to prevent wasting labor on ineffective inoculation attempts in the field.

63. (B) Burying the broodlac in the soil at the base of the tree
Burying broodlac in the soil is an incorrect and ineffective method for inoculation. Lac crawlers are tiny and delicate; they need to emerge directly onto the host branches to find succulent shoots for settlement. Placing them in the soil would prevent them from reaching the tree canopy, leading to total mortality and failure to establish the new lac crop on the host.

64. (D) Pests migrate from broodlac to the new crop.
Delaying the removal of phunki beyond the recommended three-week period poses a significant risk because these empty sticks often harbor harmful predators and parasitoids. If left on the tree, these pests can easily migrate to the newly settled lac crawlers, causing high mortality and reducing the eventual yield. Prompt removal is a key cultural practice for effective integrated pest management.

65. (A) P-4, Q-1, R-2, S-3
Identifying host plants by their common names is essential for field workers. Butea monosperma is commonly known as Palas, Ziziphus mauritiana is called Ber, Schleichera oleosa is recognized as Kusum, and Cajanus cajan is the well-known Pigeon pea or Arhar. Each of these plants plays a specific role in the cultivation of either Rangeeni or Kusmi strains of lac insects.

66. (B) 6 months
To maintain the long-term productivity and health of Butea monosperma trees, they are conventionally rested for about six months between successive lac crops. This period allow the trees to replenish their nutrient reserves and produce a fresh canopy of succulent shoots. Regular resting prevents tree exhaustion and ensure that the host remains a viable environment for future lac insect populations.

67. (A) Serving as broodlac for the massive Baisakhi crop
The harvest obtained from the Katki crop of the Rangeeni strain is primarily used as broodlac for inoculating the subsequent Baisakhi crop. Since the Baisakhi crop is the largest and most commercially significant crop in India, ensuring a high-quality supply of broodlac from the Katki season is essential for the overall success and continuity of the lac industry in the region.

68. (D) Thick circular disks rather than thin flakes.
Button lac and shellac are both refined forms of lac, but they differ in their physical shape due to the way they are processed. Shellac is stretched into very thin, brittle sheets that are then broken into flakes. Button lac, however, is formed by dropping melted lac onto a cool surface, creating thick, circular, button-like disks. Their chemical properties remain similar.

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69. (B) Tunnelling and consuming insects and resin.
The white lac moth, Eublemma amabilis, is a highly destructive predator. Its larvae penetrate the lac encrustation and create tunnels as they feed on both the live lac insects and the secreted resin. This activity not only reduces the total

89. (B) Let crawlers pass but block pests.
The sixty-mesh synthetic netting used for broodlac bundling is designed with a very specific pore size. It is large enough to allow the microscopic lac crawlers to emerge freely and colonize the host tree but small enough to act as a physical barrier against larger predatory moths and parasitoids. This mechanical control method is vital for ensuring a healthy start for the crop.

90. (B) I and III
Statements I and III are incorrect because synthetic pyrethroids are generally too toxic for use during crawler emergence, and fungicides are used to control fungal growth, not to kill lepidopteran pests like Eublemma amabilis. In contrast, indoxacarb is a selective insecticide that is safer for lac insects while remaining effective against their predators, making it a valuable tool for integrated management.

91. (A) Ectoparasitoid of lepidopteran larvae.
Bracon greeni is a beneficial insect used in the biological control of lac pests. It acts as an ectoparasitoid, meaning it lays its eggs on the surface of its host, which are the larvae of lepidopteran predators like the white lac moth. The emerging Bracon larvae then feed on the predator, effectively reducing the pest population and protecting the lac resin crop.

92. (C) Piercing and sucking mouthparts
The defining characteristic of the order Hemiptera, which includes the lac insect, is the presence of specialized piercing and sucking mouthparts forming a rostrum. These insects use this structure to penetrate plant tissues and extract liquid nutrients from the phloem. This feeding mechanism is fundamental to their biology and is directly responsible for the acquisition of materials needed for resin secretion.

93. (D) Anthraquinones
Laccaic acid, the primary component of the natural crimson dye found in lac, belongs to the chemical class of anthraquinones. These compounds are known for their strong coloring properties and have been used for centuries in textile dyeing and painting. In the lac insect, this acid is a metabolic byproduct that remains dissolved in the liquid secretion until it is washed away during processing.

94. (C) The second nymphal instar stage
Sexual dimorphism in Kerria lacca becomes visually apparent during the second nymphal instar stage. At this point, the resinous cells of males and females begin to develop distinct shapes. Male cells become more elongated and slipper-like, while female cells remain more rounded. Identifying these differences early on allows cultivators to assess the population structure and potential resin yield of the developing crop.

95. (A) Both A and R are true and R is the correct explanation of A.
The adult female lac insect is completely unable to relocate after the initial settlement phase. This permanent immobility is a direct result of the degeneration of her legs and antennae during the post-embryonic molts. By losing these appendages, the female becomes a sedentary organism focused entirely on feeding and resin production, remaining enclosed within her protective cell for the remainder of her life.

96. (D) Hatching of eggs in the female cell.
The phenomenon of swarming is triggered by the hatching of eggs within the protective incubation chamber of the female lac insect. Once the eggs hatch, the tiny first instar nymphs, or crawlers, emerge from the mother's cell through the anal opening. This massive and synchronized emergence marks the beginning of a new generation and the ideal time for field inoculation.

97. (A) Humid forests with Kusum trees.
The Kusmi strain of lac insects is primarily adapted to more humid forest environments where its definitive host, the Kusum tree (Schleichera oleosa), is naturally abundant. These regions provide the stable microclimate and nutritional resources necessary for the production of high-quality, light-colored resin. This specific habitat preference distinguishes the Kusmi strain from the more widely distributed and hardy Rangeeni strain.

98. (C) Host abundance is lower than Palas.
Although the Kusmi strain produces superior quality lac, its commercial expansion is limited compared to the Rangeeni strain primarily due to the lower abundance of its primary host trees. Kusum trees are less common and more localized than Palas (Butea monosperma),

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for the settlement of lac insect crawlers. These tender shoots provide suitable feeding sites, promoting healthy insect growth and higher lac yield. Regular pruning and canopy management therefore improve brood settlement, resin production, and the overall productivity of lac cultivation.

80. (D) Vigorous growth and high sap suitability.
The length of the internodes on new shoots is a reliable indicator of the host plant's physiological state. Longer internodes generally signify vigorous growth and a high suitability of the sap for supporting lac insects. When selecting branches for inoculation, choosing those with robust growth ensures that the insects will have an abundant and consistent supply of nutrients throughout their life cycle.

81. (A) Crawler self-dispersal to new shoots.
Natural inoculation, also known as self-inoculation, occurs when the crawlers from a mature lac crop emerge and move directly onto the new shoots of the same or adjacent trees without human intervention. In contrast, artificial inoculation involves humans harvesting broodlac and tying it onto specific trees. While natural inoculation saves labor, it can lead to over-crowding and increased pest populations in the plantation.

82. (C) Heavy, continuous monsoon showers
Heavy and continuous monsoon showers during the crawler settlement phase are extremely detrimental. The forceful raindrops can physically wash the tiny, mobile nymphs off the host branches before they have a chance to secure themselves and begin feeding. This leads to massive mortality and significantly reduces the density of the final lac encrustation, often resulting in severe economic losses for cultivators.

83. (A) Maintain insect vigor and reduce parasites.
Systematically alternating between different host species, such as using Palas for one season and Ber for the next, is a recommended practice to maintain the biological vigor of the lac insect population. This rotation can also help in breaking the life cycles of host-specific pests and parasites, leading to healthier crops and more consistent yields of high-quality resin over time.

84. (D) Final volume of commercial broodlac.
Harvesting lac in the Ari stage significantly decreases the final volume of commercial broodlac available for the next season. Because the insects are harvested before they reach reproductive maturity, they cannot produce the crawlers needed to inoculate future crops. This depletion of "seed" material creates a supply chain gap, forcing cultivators to purchase expensive broodlac from other regions to continue farming.

85. (B) Excretion of honeydew by lac insects.
The presence of sooty mold on the leaves and branches of host trees is a secondary indicator of lac insect activity. The insects excrete a sticky, sugar-rich substance called honeydew. This honeydew provides a perfect substrate for the growth of dark-colored fungal species, resulting in the characteristic "sooty" appearance. While the mold itself is harmless, it signals a dense insect population.

86. (C) Lac dye and insect debris
During the conversion of sticklac to seedlac, the primary goal of aqueous washing is the removal of the water-soluble lac dye and various biological impurities like dead insect bodies and debris. The removal of these components is crucial for refining the lac, as it improves the purity and clarifies the color of the resin, making it suitable for industrial applications.

87. (D) Storage in poorly ventilated areas.
Pseudohypatopa pulverea is particularly destructive when harvested lac is stored in poorly ventilated areas. These conditions allow the pest to continue feeding and breeding within the stored sticklac or seedlac, leading to further loss of resin and increased contamination with silk and frass. Proper ventilation and storage hygiene are essential to protect the value of the lac after it is harvested.

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88. (A) Encyrtidae
Tachardiaephagus tachardiae is a prominent hymenopteran parasitoid of the lac insect and belongs to the family Encyrtidae. This family is well-known for including many species that act as internal parasitoids of scale insects. In the context of lac cultivation, this wasp is considered a significant pest because it contributes to high mortality rates in both the Rangeeni and Kusmi strains.

inoculation of the Aghani crop, which follows the Jethwi season in the cycle.

127. (B) Sharp stipular spines on branches.
Ziziphus mauritiana, commonly known as Ber, is a valuable host for both lac strains. However, its cultivation is more labor-intensive because the branches are covered with sharp stipular spines. These spines can make manual operations like pruning, inoculation, and harvesting more difficult and time-consuming for workers. Despite this challenge, Ber remains a preferred host due to its high productivity and vigor.

128. (D) To maintain high host plant vigor under the heavy stress of lac encrustation.
Flemingia semialata is a fast-growing shrub that requires consistent moisture to remain productive. Intensive lac cultivation puts significant physiological stress on the host plant because the insects drain large amounts of nutrients and water from the phloem. Providing irrigation or planting in high-moisture regions ensures that the plant maintains the high vigor needed to support a heavy, high-yield lac encrustation.

129. (A) Prevent bark tearing on the main trunk.
When pruning heavy branches of a Kusum tree, a step-cut or three-cut method is highly recommended. This technique prevents the weight of the falling branch from tearing a long strip of bark down the main trunk. Protecting the bark is essential for the health of the tree, as large wounds can become entry points for pathogens and pests.

130. (A) I and II
Standard fertilizer application and high-density planting are beneficial practices for maintaining healthy and productive lac host plantations, making statements I and II correct. However, monthly total defoliation is not required and would be harmful to the tree's health. Proper management focuses on ensuring host vigor and providing an ideal environment for the settlement and growth of the lac insects.

131. (A) Approximately 1 to 2 weeks prior to the anticipated swarming
Broodlac should be harvested about one to two weeks before the expected swarming date. This ensures that the gravid females are fully mature but have not yet released their crawlers. Harvesting at this time allows for the preparation and transportation of the broodlac to new host trees, ensuring that inoculation occurs exactly when the crawlers begin their mass emergence.

132. (D) Egg movement into incubation chamber.
The appearance of a distinctive "yellow spot" on a mature female lac cell is a key physiological indicator. It signifies that the female has ceased resin secretion and that her eggs have moved into the anal area or incubation chamber. This visual sign is used by cultivators to predict the onset of swarming, allowing for the timely harvest of broodlac.

133. (B) Surface area of suitable tender shoots.
The amount of broodlac tied to a host tree is primarily determined by the surface area of available tender, succulent shoots. Using too much broodlac leads to overcrowding and competition among crawlers, while too little results in a patchy and unproductive encrustation. Farmers must balance the quantity of broodlac with the tree's capacity to support the settling insects for optimal yield.

134. (C) Resin becomes harder to remove mechanically.
Determining the correct time for scraping phunki, or empty broodlac, is essential for maximizing resin recovery. If the scraped sticks are left for too long, the resin can dry out further and become increasingly brittle and bonded to the woody tissue. This makes mechanical removal more difficult and less efficient, potentially leading to lower yields and higher processing costs in the future.

135. (B) III, IV, V, II, I
The life cycle of the male lac insect follows a specific biological progression. It begins as an egg (III), which hatches into a first instar nymph or crawler (IV). This is followed by a prepupal stage (V) and then a pupal stage (II), during which the insect undergoes metamorphosis. Finally, the adult male (I) emerges to fertilize the sedentary females.

136. (A) Facilitate natural inoculation for next crop.
Partial harvesting is a strategy where some lac-bearing branches are left on the tree instead of being harvested. This allows the crawlers from the mature encrustations to emerge and naturally colonize the new shoots of the same tree. While it saves the labor of manual inoculation, it must

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which is widespread across central India. This difference in host availability dictates the regional distribution and total volume of Kusmi lac production.

99. (A) Heavy monsoon rains washing crawlers.
The early establishment of the Aghani crop, which is inoculated in June or July, is primarily challenged by the arrival of heavy monsoon rains. Forceful rainfall can wash the tiny, newly emerged crawlers off the host branches before they can successfully settle and begin feeding. This environmental factor is a significant risk that can lead to poor settlement density and reduced yields.

100. (B) P-4, Q-3, R-2, S-1
Each lac crop has a specific seasonal cycle. The Baisakhi crop is harvested in June/July of the following year, the Katki crop in October/ November, the Aghani crop in January/ February, and the Jethwi crop in June/July. Understanding these harvest timings is essential for farmers to plan their labor and ensure they have a continuous supply of lac and broodlac for subsequent seasons.

101. (B) Thin-barked, tender and succulent new shoot growth
Successful crawler settlement is most directly facilitated by the presence of thin-barked, tender, and succulent new shoots. These young branches are much easier for the microscopic nymphs to pierce with their mouthparts compared to older, lignified bark. Providing an abundance of such growth through systematic pruning is therefore a primary objective for achieving high settlement density and a productive lac crop.

102. (C) Cultivation of lac on agricultural lands as a plantation crop
The adoption of Flemingia semialata is highly advantageous because it allows lac to be cultivated as a high-density plantation crop on regular agricultural lands. Its bushy nature and rapid growth make management much easier than working with tall, scattered trees. This transition to a plantation model facilitates more intensive farming practices, leading to higher productivity and better quality control in lac resin production.

103. (B) February
For raising the Katki crop on Ziziphus mauritiana (Ber), pruning is generally performed during February. This schedule ensures that the tree has enough time to produce fresh, succulent shoots by June or July when inoculation takes place. Proper timing is critical to synchronize host plant phenology with the life cycle of the lac insect, ensuring optimal conditions for settlement and growth.

104. (A) Depletes reserves, causing poor flush.
Over-pruning a lac host tree can have detrimental effects as it severely depletes the plant's stored nutrient reserves. This metabolic stress results in a poor or weak flush of new shoots, which are necessary for the settlement of lac crawlers. In the long run, repeated over-pruning can lead to tree exhaustion, reduced productivity, and even the eventual death of the host plant.

105. (B) I, II and III
High-quality broodlac is characterized by thickly encrusted sticks, continuous encrustation, and an absence of excessive predator webbing, making statements I, II, and III correct. Conversely, a high percentage of dead or empty cells is a negative indicator, as it means fewer crawlers will emerge. Proper grading ensures that only healthy, productive material is used for inoculation, maximizing the chances of crop success.

106. (B) Ensures direct crawler path to shoots.
When tying broodlac bundles to host trees, it is essential to keep the sticks in intimate contact with the branches. This close physical connection provides a direct and easy path for the emerging crawlers to move from the broodlac to the new, succulent shoots of the tree. Ensuring this efficient migration is critical for achieving high settlement density and a successful inoculation.

107. (A) Prevent resin bonding to dry wood.
Scraping the phunki, or empty broodlac, should be done immediately after its removal from the tree. If the sticks are allowed to dry out completely, the resin can become more firmly bonded to the wood, making mechanical separation more difficult and potentially damaging the quality of the sticklac. Prompt scraping ensures maximum recovery of the resin in a clean and efficient manner.

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characterized by the position of their mouthparts. The rostrum or beak appears to arise from the posterior part of the head, often situated between or behind the fore coxae. This group is exclusively composed of plant-sap feeders that use specialized mouthparts to pierce and suck nutrients.

50. (C) Lac wax
Lac wax is a minor but essential component of the resin secreted by the lac insect. It plays a critical role in providing the characteristic plasticity and flow required for various commercial molding and coating applications. While the resin provides the structure, the wax ensures the final product, such as shellac or button lac, has the desired physical properties for industrial use.

51. (A) Brachial pores
The respiratory system of the mature female lac insect is connected to the external environment through specialized structures called brachial pores. These pores are located on the brachial plates and allow for gaseous exchange. To prevent these vital openings from being blocked by the secreted resin, the insect produces long, white wax filaments that maintain a clear path to the air.

52. (D) Polymerization of fatty acids and terpenes.
The hardening of lac secretion upon exposure to the atmosphere is a complex biochemical process. It primarily involves the polymerization of various hydroxy fatty acids and sesquiterpene acids present in the liquid secretion. This reaction transforms the fluid into a solid, protective resinous cell. This unique natural polymer is highly valued for its ability to form durable, glossy films in industrial applications.

53. (B) Body expansion and increased resin secretion.
Following fertilization, the female lac insect undergoes significant physiological changes to support the development of eggs. Her body expands rapidly, and there is a marked increase in the rate of resin secretion. This period is when the bulk of the commercial lac encrustation is formed. The female remains sedentary within her growing resinous cell until the life cycle is complete.

54. (C) Lower surface of tender, succulent shoots
Lac crawlers show a distinct preference for settling on the lower surface of tender, succulent shoots. These areas have thinner bark, making it easier for the tiny nymphs to pierce the tissue with their mouthparts and reach the nutrient-rich phloem sap. This targeted settlement leads to the formation of dense encrustations that are ideal for high-yield commercial lac harvesting.

55. (A) Both A and R are true and R is the correct explanation of A.
The Kusmi strain of lac insects generally fails to thrive on Butea monosperma, also known as Palas. This is because the nutritional profile and the timing of sap flow in Palas do not meet the specific physiological requirements of the Kusmi strain. Consequently, successful cultivation of high-quality Kusmi lac is restricted to its primary hosts like Kusum and certain compatible trees.

56. (A) Starvation due to arrested host sap flow.
During the intense summer phase of the Baisakhi crop, high temperatures can cause host trees to go into a state of semi-dormancy or experience reduced sap flow. This results in the starvation of the developing lac insects, as they cannot obtain sufficient nutrients. This physiological stress is a major cause of mass mortality, often forcing farmers to harvest the crop prematurely.

57. (A) June to July
The inoculation of the Aghani crop, which is the winter crop of the Kusmi strain, typically occurs during the months of June or July. This timing ensures that the crawlers settle on the host trees during the monsoon season. The crop then matures over the following months and is harvested in January or February of the next year.

58. (B) Supports both Rangeeni and Kusmi strains.
Ziziphus mauritiana, commonly known as Ber, is considered a versatile host plant because it can successfully support both the Rangeeni and the Kusmi strains of lac insects. This flexibility makes it a highly valuable species in lac-growing regions, allowing farmers to switch between strains or crops depending on the availability of broodlac and prevailing market conditions for different qualities of lac.

59. (A) Intensive irrigation and fertilization.
Cultivating lac on Flemingia semialata requires a more intensive agronomic approach compared to traditional large tree hosts. Because it is a fast-growing, bushy shrub often planted in high-

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cheaper synthetic resins derived from petroleum. These synthetic alternatives offered consistent properties at a lower cost, leading many industries to switch away from natural shellac for various coating, molding, and finishing applications in manufacturing.

118. (C) Male cells are slipper-like; females globular.
Field workers can easily distinguish between male and female lac insects during their later developmental stages by observing the shape of their resinous cells. Male cells are characteristically elongated and resemble a slipper, while female cells are more globular or rounded. This visual distinction is critical for assessing the sex ratio and predicting the eventual resin yield of the developing crop.

119. (D) Brachial tubes extending to ambient air.
A defining characteristic of the lac insect's respiratory system is the presence of brachial tubes. These structures extend from the insect's body through the resinous cell to the ambient air, allowing for essential gaseous exchange. To keep these passages open, the insect secretes long, white wax filaments that prevent the hardening resin from blocking the flow of air to the spiracles.

120. (A) Both A and R are true and R is the correct explanation of A.
Swarming in lac insects is a highly synchronized event that is influenced by environmental cues. Crawlers typically emerge during the warmer morning hours when conditions are favorable for their activity and movement. This behavior is a response to specific temperature and light signals, ensuring that the maximum number of nymphs can successfully find and settle on new host plant shoots.

121. (B) They develop parthenogenetically into female offspring in rare strains.
In most populations of Kerria lacca, reproduction is sexual. However, in some rare strains, unfertilized eggs can undergo a process called parthenogenesis. This allows the eggs to develop into viable female offspring without the need for fertilization by a male. While this is not the primary mode of reproduction, it provides a fascinating biological mechanism for population survival in specific environmental contexts.

122. (B) The Chotanagpur plateau (Jharkhand and surrounding areas)
The Chotanagpur plateau, covering parts of Jharkhand and neighboring states, is historically the most prominent region for lac cultivation and processing in India. This area provides the ideal environmental conditions and a high concentration of primary host trees like Palas, Kusum, and Ber. Consequently, it has remained the heart of the global lac industry for over a century, supporting numerous farming communities.

123. (A) Produces darker, dye-rich resin.
The Rangeeni strain of lac insect is named primarily because of its characteristic resin, which is darker and contains a higher concentration of the crimson lac dye compared to the Kusmi strain. The term "Rangeeni" suggests color or being colorful. This strain is widely cultivated due to its hardiness and ability to thrive on a variety of common host trees.

124. (C) Winter cold and delayed summer sap flush.
The Baisakhi crop has an unusually long duration, lasting eight to nine months, primarily because its development spans the winter season. The cold winter temperatures slow down the metabolic rates of the lac insects, extending their nymphal period. Additionally, the crop must wait for the host tree to produce a fresh, succulent sap flush in the early summer before maturing.

125. (A) P-3, Q-4, R-1, S-2
Integrated pest management in lac cultivation involves various strategies. Mechanical control is exemplified by using sixty-mesh synthetic netting for broodlac. Chemical control involves the selective use of insecticides like indoxacarb. Biological control is practiced by releasing beneficial parasitoids like Bracon greeni. Finally, cultural control includes the timely removal of phunki sticks to prevent the migration of pests to the new crop.

NODIA

126. (A) June to July
The Jethwi crop is the summer crop of the Kusmi strain. It is typically inoculated in January or February and matures throughout the summer. The emergence of the next generation of crawlers, or swarming, occurs during the months of June or July. This timing is crucial for the subsequent

quantity of lac harvested but also contaminates the remaining resin with silk and frass, significantly lowering its quality and commercial value.

70. (C) Early to mid-nymphal and early adult stages
Tetrastichus purpureus is a common parasitoid that primarily attacks the lac insect during its early to mid-nymphal stages and the early adult phase. By laying eggs inside the developing insect, the parasitoid larvae consume the host's internal tissues, leading to high mortality rates. This pest is a major factor in reducing the density and productivity of lac encrustations in the field.

71. (D) Mechanical control
The use of wire-mesh baskets or synthetic netting to enclose broodlac during inoculation is a classic example of mechanical control. This physical barrier is designed with a specific mesh size that allows the tiny lac crawlers to escape and settle on host branches while effectively trapping larger predatory moths and parasitoids. It is a simple yet highly effective method for reducing initial pest populations.

72. (A) Timely removal and destruction of phunki
The timely removal and destruction of phunki, or empty broodlac, is a foundational practice in integrated pest management. This cultural control measure serves two purposes: it ensures the proper completion of the inoculation cycle and prevents the transfer of pests from the old broodlac to the new crop. By breaking the pest life cycle, it helps maintain overall plantation health and productivity.

73. (B) Formation of a slipper-shaped test (cell)
During the pupal stage, the male lac insect develops within a specialized resinous cell known as a test. This cell is distinctively slipper-shaped, which allows for easy field identification of male insects. In contrast, the female cell is generally more globular or rounded. The development of this unique structure marks the transition of the male from a nymph to a reproductive adult.

74. (B) Moderate temperatures and seasonal rainfall.
Lac insects are biologically adapted to thrive in ecological environments characterized by moderate temperatures and distinct seasonal rainfall. Extremes of heat or cold, as well as continuous torrential rain, can be detrimental to their survival and resin production. These specific climate requirements are why commercial lac cultivation is concentrated in certain tropical and subtropical regions of Asia, such as central India.

75. (B) I, III and IV
The female lac insect undergoes incomplete metamorphosis, remains sedentary after initial settlement, and secretes resin continuously until death, making statements I, III, and IV correct. However, adult females are completely wingless, and they produce both male and female offspring through sexual reproduction. Understanding these biological realities is essential for managing populations and optimizing resin yields in commercial lac farming operations.

76. (C) 60-70%
The Baisakhi crop is the most significant season for lac production in India, accounting for approximately sixty to seventy percent of the total annual Rangeeni lac yield. Its long duration and the widespread availability of suitable host trees during this period contribute to its dominance. The success of this crop is a major driver of the local economy for lac-growing communities.

77. (D) Annual or short-lived, requiring replanting.
While Cajanus cajan, or Pigeon pea, can serve as a host for lac insects, its primary disadvantage is its short life span. Unlike perennial trees like Kusum or Palas, it is often treated as an annual or short-lived plant. This requires frequent replanting, which increases labor and costs for the farmer. Consequently, it is mostly used as a minor or supplemental host.

78. (C) Flush with the main stem without leaving a stump
When pruning Butea monosperma for lac cultivation, the best practice is to make cuts flush with the main stem or parent branch. Leaving a stump can lead to poor healing and increase the risk of fungal infections. A clean, flush cut encourages the rapid emergence of healthy, succulent shoots that are ideal for the subsequent settlement and feeding of lac crawlers.

79. (B) Providing succulent shoots for settlement
Maintaining proper canopy architecture in lac host trees ensures the continuous production of young, succulent shoots, which are essential

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be managed carefully to prevent the buildup of pest populations in the plantation.

137. (B) Lac dye
During the primary aqueous washing of crushed sticklac, a valuable crimson dye is extracted. This water-soluble dye was once the most important commercial product of the lac industry. Today, it remains an important natural coloring agent for the textile, food, and cosmetic industries. Removing the dye is also a necessary step for refining the resin into high-quality seedlac and shellac.

138. (B) Bleach the shellac and remove the residual color.
Sodium carbonate or other mild alkalis are sometimes added during the hot processing of seedlac to act as bleaching agents. This chemical intervention helps to remove residual lac dye and lighten the color of the final shellac. Producing lighter-colored shellac is often a priority, as it commands a higher market price and is preferred for fine industrial finishes and transparent coatings.

139. (A) Silken webs with fecal frass on encrustation.
A clear and visible symptom of a heavy Eublemma amabilis infestation is the presence of silken webs and dark fecal frass on the lac encrustation. The predator larvae spin these webs as they tunnel through the resin and feed on the insects. Observing these signs in the field is a warning of significant crop damage and necessitates immediate pest management interventions to protect yield.

140. (B) II and IV
Statements II and IV are incorrect because Bracon greeni targets the larval stage of lepidopteran predators, not the lac insect itself, and biological control is meant to be a component of integrated management, not a total replacement for cultural practices. Trichogramma species are indeed effective egg parasitoids, and mass rearing of such agents is a cornerstone of modern sustainable lac pest control.

141. (D) Predators emerging from the broodlac.
Using insect-proof wire-mesh baskets for artificial inoculation is a highly effective mechanical control measure. The mesh size is precisely calibrated to allow the microscopic lac crawlers to escape and settle on host branches while physically trapping any predators and parasitoids that emerge from the broodlac sticks. This technique drastically reduces the initial pest pressure on the new, vulnerable lac insect population.

142. (C) Fermentation products of the actinomycete Saccharopolyspora spinosa.
Spinosad is a modern insecticide that is derived from the fermentation products of a soil-dwelling bacterium called Saccharopolyspora spinosa. It is highly valued in lac integrated pest management because it effectively controls lepidopteran pests like Eublemma amabilis while having a favorable safety profile for the lac insect and other non-target organisms. This makes it an excellent choice for sustainable agriculture.

143. (B) Cultural controls like timely phunki removal.
In an integrated pest management strategy for lac cultivation, cultural controls such as the timely removal of phunki sticks are considered the foundational "first line of defense." These practices are simple, low-cost, and highly effective at breaking the life cycles of major pests without the need for chemical intervention. Strong cultural management significantly reduces the reliance on more expensive controls.

144. (D) Superfamily Coccoidea
In the taxonomic hierarchy of the lac insect, the position immediately above the family Kerriidae is the superfamily Coccoidea. This group encompasses all scale insects and mealybugs. Above this is the suborder Sternorrhyncha, followed by the order Hemiptera. Understanding this classification is essential for researchers to study the evolutionary relationships and shared biological characteristics within this diverse group of insects.

145. (A) Both A and R are true and R is the correct explanation of A.
The commercial value of shellac is heavily influenced by its color, with lighter shades generally being more desirable. This is because darker shellac often indicates the presence of more impurities or polymerized resin, which can limit its use in high-end industrial finishes and delicate coatings. Consequently, the refining process often focuses on removing as much dye and color as possible.

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(B) I and II
(C) II
(D) I

2024

16. The waggle dance performed by Apis mellifera foragers communicates which specific information to nestmates?
(A) The exact chemical and nutritional composition of the discovered nectar
(B) The presence of parasitic Varroa mites within the colony's brood cells
(C) The imminent requirement for the entire colony to swarm and relocate
(D) The distance and direction of a rich floral resource relative to the sun

2024

17. What is a primary disadvantage of relying exclusively on Apis mellifera for commercial crop pollination?
(A) High susceptibility to colony collapse and mites, threatening pollination stability
(B) High levels of aggression that make them difficult to manage in artificial boxes
(C) Inability to pollinate commercially important tree fruits like almonds and apples
(D) Total failure to collect nectar, which limits attraction to a broad variety of flowers

2001

18. Based on the nesting behavior of solitary leaf-cutter bees, which management practice would most likely increase their local populations in an agricultural setting?
(A) Applying broad-spectrum insecticides to eliminate competing insects
(B) Removing all non-crop vegetation and hollow stems from the field borders
(C) Providing artificial wooden nesting blocks with pre-drilled holes
(D) Supplying artificial nectar substitutes in large open trays

2011

19. Identify the correct statement regarding the biology of bumblebees (Bombus spp.).
(A) New colonies are founded in the spring by a single overwintered, mated queen
(B) Bumblebee colonies survive perpetually for multiple years in temperate climates
(C) Bumblebees communicate floral locations primarily through complex tactile dances
(D) The majority of bumblebee species construct large aerial hives suspended from tree branches

2004

20. Consider the following statements about hymenopteran biology:
I. Honeybees exhibit age polyethism, where workers perform different tasks as they age.
II. Solitary bees provide progressive provisioning to their larvae throughout their development.
III. Bumblebees utilize buzz pollination to extract pollen from crops like blueberries.
IV. Leaf-cutter bees line their brood cells with glandular wax secretions.
Which of the above statement(s) is/are correct?
(A) I and III
(B) I, II and IV
(C) II and III
(D) I, III and IV

2018

21. Which specialized anatomical structure in female fig wasps (Agaonidae) allows them to transport pollen from one fig inflorescence to another?
(A) Corbicula
(B) Mesothoracic pockets
(C) Scopa
(D) Coronal scales

2014

22. The introduction of Elaeidobius kamerunicus to Southeast Asian oil palm plantations resulted in which primary effect?
(A) Complete defoliation of the oil palm canopy during the annual dry season
(B) Transmission of a lethal viral disease to the native palm tree species
(C) Increased fruit set and yield without the need for manual pollination
(D) Competitive exclusion and local extinction of native honeybee populations

2011

23. Which of the following is NOT a characteristic of the specialized mutualism between fig trees (Ficus spp.) and fig wasps (Agaonidae)?
(A) The female wasp enters the syconium through a narrow ostiole to oviposit
(B) The developing wasp larvae feed on gall tissue within specialized short-styled flowers
(C) The female wasp actively or passively deposits pollen on the stigmas of long-styled flowers
(D) The male wasps fly extensively between different trees to find unfertilized females

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156. (C) Stimulation of fresh succulent lateral shoots.
Proper pruning of a lac host tree breaks apical dominance, which directs the plant's energy toward the development of lateral buds. This results in the stimulation of numerous fresh, succulent lateral shoots. These young branches are the ideal substrate for lac crawlers to settle and feed upon, making pruning one of the most important agronomic interventions for maximizing lac resin yield.

157. (D) Re-inoculating without resting the branches.
Re-inoculating host branches without providing a proper resting period is considered a poor agronomic practice. Continuous cultivation without breaks leads to tree exhaustion and reduced vigor, as the plant cannot replenish its sap and nutrient reserves. This eventually results in poor crop yields and branch dieback, compromising the long-term sustainability and health of the entire lac plantation and its income.

158. (C) Storage in deep piles or unventilated bags.
The quality of harvested broodlac can be rapidly compromised if it is stored incorrectly. Keeping broodlac in deep piles or unventilated bags leads to heat buildup and a lack of fresh air, which can kill the developing embryos inside the cells. Proper storage in well-ventilated, shaded areas is essential to maintain the viability of the insects until they are inoculated.

159. (B) Tied parallel and firmly to the host shoot.
During artificial inoculation, the recommended orientation for the broodlac stick is to tie it parallel and firmly against the host branch. This close, secure contact provides a stable and direct bridge for the emerging crawlers to move from the broodlac to the new succulent shoots. Ensuring this ease of migration is critical for achieving a dense and uniform settlement across the tree.

160. (D) Scraping
Scraping is the specific post-harvest operation defined as the physical separation of the raw lac encrustation from the host plant twigs. This process is usually done manually or with simple tools to collect the resin, which is then known as sticklac. It is a critical step in the primary processing of lac, as it provides the raw material for all subsequent refining.

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146. (C) Aleuritic acid
Aleuritic acid is a major chemical component extracted from lac resin and is highly valued in the cosmetics and pharmaceutical industries. Its excellent film-forming properties make it an ideal ingredient for products like hair sprays, nail polishes, and enteric coatings for pills. The extraction of this acid from natural shellac adds significant value to the commercial processing of lac.

147. (A) Fused resin secretions of settled insects.
The formation of a continuous lac encrustation on a host branch occurs because the individual resinous cells of the settled insects eventually fuse together. As each insect secretes resin to build its own protective cell, the growing boundaries of these cells meet and merge. This results in a thick, solid layer of resin that completely covers the branch, which is then harvested.

148. (D) Unabsorbed plant sugars and amino acids.
Honeydew is a sticky, sweet substance excreted by lac insects as a byproduct of their feeding. It is primarily composed of unabsorbed sugars and amino acids from the host plant's phloem sap. While honeydew itself is not the commercial product, its presence can lead to the growth of sooty mold and attract ants, which can influence the local insect ecosystem.

149. (B) Genetically polymorphic trait in populations.
The occurrence of both winged and wingless (apterous) forms in male lac insects is a genetically polymorphic trait within the population. This variation may serve as an evolutionary strategy for dispersal and mating. Winged males can fly to find distant females, while wingless males are specialized for fertilizing females in the immediate vicinity. This polymorphism ensures reproductive success across different environments.

150. (A) P-3, Q-2, R-4, S-1
Accurate anatomical knowledge is vital for studying lac insects. The anal tubercle is used for honeydew excretion, while brachial pores are the openings for respiration. The operculum is a specialized hardened plate that covers the anal opening in male pupae. Finally, the crawler is the name given to the mobile first instar nymph. Together, these structures define the insect's biology.

151. (D) Rapid desiccation and high crawler mortality.
Exposure to ambient temperatures exceeding forty degrees Celsius during the swarming phase is extremely dangerous for lac crawlers. These tiny, mobile nymphs are highly susceptible to rapid desiccation due to their small body size and lack of protective resin during dispersal. High heat can lead to massive mortality before they can settle, potentially causing total failure of the newly inoculated crop.

152. (A) Wider climate tolerance and host abundance.
The Rangeeni strain dominates total lac production because of its wider climate tolerance and the greater abundance of its primary host trees, such as Butea monosperma (Palas). While the Kusmi strain produces higher-quality resin, its primary host (Kusum) is less common and localized. The hardiness of the Rangeeni strain allows it to be cultivated across a much larger geographic area.

153. (B) Baisakhi
Noticing heavy swarming in late October or early November indicates the initiation of the Baisakhi crop cycle. At this time, the crawlers from the previous Katki crop are emerging to colonize new host branches. The Baisakhi crop is the most significant season for Rangeeni lac production, and this October inoculation marks the start of its long, winter-spanning developmental period.

154. (B) Schleichera oleosa
To cultivate the Aghani crop, which is the winter crop of the Kusmi strain, the primary host tree that must be prepared and pruned is Schleichera oleosa (Kusum). This tree provides the essential nutritional environment required by the Kusmi strain to produce high-quality, light-colored resin. Proper pruning of the Kusum tree ensures a fresh flush of shoots for inoculation in June.

NODIA

155. (A) I, II and IV
Minor and alternative lac host plants are essential for bridging broodlac shortages and can be used in intensive, high-density cultivation, making statements I, II, and IV correct. While they may not yield as much per plant as a large Kusum tree, they allow for a more flexible and efficient use of land. These plants are a key part of modern lac farming.

galleries to store intact floral structures
(B) Buzz pollination (sonication) to release pollen from specialized poricidal anthers
(C) Floral constancy, where an insect visits flowers of the same species consecutively
(D) Timing foraging activities to coincide with specific diurnal floral anthesis periods

2016

9. What is the primary evolutionary effect of the development of a long, specialized proboscis in certain sphingid moths?
(A) It prevents the moths from being preyed upon by specialized nocturnal insectivores
(B) It restricts feeding to deep, tubular corollas, ensuring specialized pollination
(C) It allows them to bypass reproductive structures to extract nectar parasitically
(D) It enables the rapid mechanical breakdown of hard pollen grains before ingestion

2004

10. Match the pollinator adaptation in List I with its corresponding insect group in List II.
List I: Pollinator adaptation
P. Buzz pollination (sonication)
Q. Corbicula on the hind tibia
R. Specialized scales for pollen retention
S. Abdominal scopa for pollen transport
List II: Insect group
1. Megachilidae (Solitary leaf-cutter bees)
2. Apidae (Honeybees)
3. Bombus spp. (Bumblebees)
4. Lepidoptera (Butterflies/Moths)
(A) P-2, Q-3, R-4, S-1
(B) P-3, Q-2, R-4, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-1, Q-4, R-2, S-3

2019

11. The phenomenon of oligolecty in solitary bees refers to which of the following foraging behaviors?
(A) Collecting pollen exclusively from a single plant family or genus
(B) Foraging continuously throughout both day and night
(C) Gathering nectar from any available flowering plant regardless of morphology
(D) Switching randomly between pollen and nectar collection on different trips

2007

12. When comparing the pollination efficiency of honeybees and solitary bees in specific crops like alfalfa, which statement holds true?
(A) Honeybees are universally more efficient because of their larger colony sizes
(B) Honeybees are incapable of pollinating leguminous crops due to their short proboscis
(C) Solitary bees like the alfalfa leaf-cutter bee are more efficient as they reliably trip the alfalfa flower mechanism
(D) Solitary bees primarily extract nectar and actively avoid pollen collection, reducing their efficiency

2007

13. A horticulturist notices poor fruit set in a greenhouse tomato crop despite manual ventilation. Which specific insect should be introduced to best resolve this pollination deficit?
(A) Apis mellifera, because of their large foraging workforce
(B) Megachile rotundata, because leaf-cutter bees prefer solanaceous crops
(C) Syrphid flies, because their larvae consume greenhouse pests while adults pollinate
(D) Bombus terrestris, because tomatoes require sonication to release pollen

2019

14. Which of the following hymenopteran pollinators is INCORRECTLY paired with its biological characteristic?
(A) Apis dorsata: Open-air, single-comb nesting and foraging behavior
(B) Bombus impatiens: Annual colony cycle with overwintering queens
(C) Megachile rotundata: Complex eusocial structure with worker castes
(D) Apis florea: Dwarf honeybee exhibiting primitive dance languages

2016

15. Consider the following statements regarding major hymenopteran pollinators:
I. Bumblebees are highly effective in low-temperature conditions due to their ability to thermoregulate.
II. Solitary leaf-cutter bees construct their nests using cut plant materials rather than secreting wax.
III. All species of honeybees are strictly solitary during the overwintering phase.
Which of the above statement(s) is/are correct?
(A) I and III

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(A) Production of small amounts of medicinal honey suitable for specialized markets
(B) Capability of pollinating flowers without ever making contact with the anthers
(C) Active transport of large amounts of pollen to their nests to feed their maggots
(D) Better adaptation to confined spaces without exhibiting aggressive stinging behavior

2003

33. When comparing the pollination behavior of butterflies and hoverflies, which distinction is accurate?
(A) Butterflies typically land while feeding, whereas hoverflies frequently hover
(B) Hoverflies solely consume pollen, whereas butterflies solely consume floral tissue
(C) Butterflies are nocturnal pollinators, whereas hoverflies strictly pollinate at dawn
(D) Hoverflies prefer deep tubular flowers, whereas butterflies prefer flat inflorescences

2003

34. The lack of adequate insect cross-pollination in self-incompatible horticultural crops primarily results in which effect?
(A) Excessive vegetative growth at the expense of root development
(B) Premature abscission of leaves during the flowering stage
(C) Drastic reduction in fruit set and overall crop yield
(D) Increased susceptibility of the plant to viral pathogens

2009

35. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): Insect cross-pollination significantly improves the qualitative traits of fruits, such as shape, size, and nutritional value.
Reason (R): Insect cross-pollination prevents natural fruit drop by repelling phytophagous pests from the developing ovaries.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2018

36. In agricultural science, xenia refers to the direct effect of pollen on the maternal tissues of the seed and fruit. How does optimal insect cross-pollination maximize this effect?
(A) Mechanically scarring the stigma surface to accelerate pollen tube growth
(B) Directly altering the genetic structure of the maternal plant's somatic cells
(C) Triggering the plant to rapidly shed all unfertilized ovules from the stem
(D) Ensuring diverse, abundant pollen reaches the stigma, enhancing seed mass

2014

37. What is a notable advantage of utilizing native insect pollinators over managed honeybees for cross-pollination in specific ecosystems?
(A) Production of higher commercial yields of wax, honey, and floral propolis
(B) Superior floral fidelity and temporal synchrony with local crop varieties
(C) Complete replacement of the need for synthetic nitrogen-based fertilizers
(D) Elimination of the requirement for planting specialized floral resource buffers

2018

38. For a monoecious crop like cucurbits, which of the following is the most appropriate description of the pollinator's role?
(A) Triggering the release of airborne pollen grains from the anther structures
(B) Removing self-incompatible pollen grains from the surface of the stigma
(C) Physical transfer of pollen from staminate flowers to pistillate flowers
(D) Prevention of cross-pollination to ensure pure-line seed production in fields

2019

39. Studies indicate that adequate insect pollination in oilseed crops like sunflower and canola leads to which direct economic benefit?
(A) A reduction in the post-harvest storage requirements of the seeds
(B) A complete elimination of all fungal diseases affecting the crop
(C) A shortening of the vegetative growth phase by several weeks
(D) An increase in the total oil content and seed weight

2011

40. Match the biological control agent in List I with its target weed species in List II.
List I: Biological control agent
P. Zygogramma bicolorata

NODIA

2001

24. In the context of the oil palm pollination system, which characteristic makes Elaeidobius kamerunicus the most relevant and successful pollinator?
(A) Its exclusive feeding and breeding life cycle within male inflorescences
(B) Its large body size allows it to carry vast quantities of pollen on its scopa
(C) Its highly developed sonication ability effectively releases oil palm pollen
(D) Its aggressive defense of the oil palm inflorescence against herbivorous pests

2016

25. Consider the following statements about specialized pollinator associations:
I. Fig wasps are classified under the order Hymenoptera.
II. Male fig wasps are typically wingless and die inside the syconium after mating.
III. Oil palm weevils act as predators of oil palm pests rather than actual pollinators.
IV. The interaction between Ficus and Agaonidae is an example of obligate mutualism.
V. Elaeidobius kamerunicus relies primarily on visual cues to locate oil palm flowers.
Which of the above statement(s) is/are INCORRECT?
(A) I, II, III and V
(B) I, III and V
(C) I, II and IV
(D) II, IV and V

2012

26. The unique inflorescence of the fig plant, which completely encloses the flowers and requires specialized wasp entry, is botanically known as a:
(A) Capitulum
(B) Syconium
(C) Spadix
(D) Cyathium

2016

27. Identify the INCORRECT statement regarding non-hymenopteran pollinators.
(A) Blowflies (Calliphoridae) are entirely detrimental to crops and play no role in commercial pollination
(B) Hoverflies (Syrphidae) are significant pollinators in cooler climates and higher altitudes
(C) Certain flower beetles are specialized for pollinating large, robust flowers like magnolias
(D) Adult lepidopterans contribute to pollination while feeding on nectar via their proboscis

2021

28. If a crop produces flowers that emit a strong, putrid odor resembling decaying meat, which group of non-hymenopteran pollinators can be eliminated as the primary pollinator?
(A) Calliphoridae (Blowflies)
(B) Sarcophagidae (Flesh flies)
(C) Lepidopterans (Butterflies)
(D) Silphidae (Carrion beetles)

2014

29. The adults of the family Syrphidae are important pollinators. Under which order are they classified?
(A) Hymenoptera
(B) Coleoptera
(C) Lepidoptera
(D) Diptera

2004

30. A farmer grows seed crops of carrots and onions, which have small, shallow, and clustered flowers. Which group of non-hymenopteran insects would be highly effective applied pollinators for these specific crops?
(A) Hawk moths, due to their long proboscis and specialized hovering ability
(B) Flower beetles, due to their ability to chew through thick, fibrous floral parts
(C) Blowflies and hoverflies, as their short mouthparts access shallow nectar
(D) Fig wasps, as they specialize in entering clustered syconium inflorescences

2018

31. Which of the following non-hymenopteran pollinators is correctly paired with its specific ecological trait?
(A) Blowflies (Calliphoridae) : Adults possess a specialized pollen basket
(B) Hoverflies (Syrphidae) : Larvae of many species are predatory on aphids
(C) Flower beetles (Cetoniinae) : Exclusively perform buzz pollination
(D) Lepidopterans : Larvae are critical for soil bioturbation

2008

32. In some high-value protected agriculture systems, blowflies are reared and released specifically for pollination. What is the main reason for using blowflies instead of honeybees in small isolation cages?

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CHAPTER 18
Other Useful Insects

2010

1. Which of the following best defines the ecological category of entomophagous insects in an agricultural ecosystem?
(A) Insects that feed on other insects to regulate pest populations
(B) Insects that consume plant tissues and assist in decomposition
(C) Insects that form mutualistic relationships with angiosperms
(D) Insects that scavenge on animal remains to facilitate cycling

2005

2. Among the various categories of beneficial insects, silkworms and lac insects are primarily classified under which economic group?
(A) Entomophagous insects
(B) Weed biocontrol agents
(C) Productive insects
(D) Scavenging insects

2022

3. Which of the following statements regarding the ecological role of useful insects is INCORRECT?
(A) Pollinators are entirely restricted to the order Hymenoptera in tropical ecosystems
(B) Detritivores break down complex organic matter into simpler forms in the soil
(C) Scavenger insects prevent the accumulation of decaying animal carcasses
(D) Phytophagous insects can be utilized as beneficial agents if they selectively attack invasive weeds

2015

4. Based on their primary ecological function, which of the following represents a correct classification of the insect species?
(A) Dung beetles are classified as primary pollinators
(B) Hoverflies are classified exclusively as soil bioturbators
(C) Silphidae are classified as productive insects
(D) Ladybird beetles are classified as entomophagous predators

2012

5. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): Beneficial insects play a critical role in maintaining the ecological balance of agroecosystems.
Reason (R): Beneficial insects contribute to pest population regulation, crop pollination, and soil nutrient cycling.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2013

6. Which among the following is the most appropriate indicator of a healthy, biodiverse agricultural ecosystem utilizing natural beneficial insect categories?
(A) Complete eradication of all phytophagous insects by aggressive chemical means
(B) Dominance of a single productive insect species to maximize commercial yield
(C) Presence of diverse functional groups such as parasitoids and pollinators
(D) High populations of subterranean termites consuming only living crop roots

2008

7. Which of the following morphological adaptations is correctly paired with its primary function in floral pollination?
(A) Plumose body hairs : Penetration of tough floral nectaries
(B) Elongated proboscis : Collection of large pollen grains for larval feeding
(C) Smooth exoskeleton : Maximizing electrostatic adherence of pollen
(D) Corbicula (pollen basket) : Transport of aggregated pollen to the nest

2007

8. All of the following are behavioral adaptations of insects for floral pollination EXCEPT:
(A) Construction of elaborate underground

NODIA

Q. Dactylopius ceylonicus
R. Neochetina eichhorniae
S. Cyrtobagous salviniae

List II: Target weed species

1. Salvinia molesta (Water fern)
2. Opuntia vulgaris (Drooping prickly pear)
3. Parthenium hysterophorus (Congress grass)
4. Eichhornia crassipes (Water hyacinth)

(A) P-3, Q-2, R-4, S-1
(B) P-1, Q-4, R-2, S-3
(C) P-3, Q-4, R-2, S-1
(D) P-2, Q-3, R-1, S-4

2011

41. All of the following are fundamental principles required for a successful classical weed biological control program EXCEPT:
(A) High host specificity of the biocontrol agent
(B) Broad polyphagy to ensure the agent survives even if the target weed is eliminated
(C) Ecological adaptation of the agent to the introduced environment
(D) Rapid reproductive rate of the biocontrol agent relative to the weed

2009

42. Identify the correct statement regarding the mechanism of weed biocontrol by phytophagous insects.
(A) Eradication of 100% of the target weed population within a single growing season
(B) Suppression of vigor by defoliating, mining, or boring into critical tissues
(C) Physical uprooting of the weeds using specialized fossorial forelegs of adults
(D) Transmission of lethal synthetic herbicides from the leaf surface to the roots

2017

43. Before an exotic phytophagous insect is introduced into a new country for weed biocontrol, rigorous host-specificity testing is conducted. What can be directly inferred from this mandatory protocol?
(A) Protection against switching to economically important or native plants
(B) Maximization of the insect's ability to feed on a wide range of native crop plants
(C) Guaranteeing the rapid eradication of the weed within a single insect generation
(D) Permanent alteration of the genetic makeup of the biological control agent used

NODIA

2021

44. Based on their feeding strategy, biocontrol agents that develop entirely within the plant stem and disrupt vascular transport are classified as:
(A) Defoliators
(B) Leaf miners
(C) Stem borers
(D) Gall formers

2016

45. A researcher observes that a newly introduced biocontrol insect rapidly defoliates the target weed, but the weed quickly regrows from robust underground rhizomes. Which concept should be applied to improve control?
(A) Introduction of a sterile insect technique to reduce the biocontrol population
(B) Application of a broad-spectrum insecticide to aid the weed's natural recovery
(C) Replacing the insect agent exclusively with a larger vertebrate herbivore
(D) Integration of multiple agents targeting different parts, such as root feeders

2022

46. What is the primary ecological effect of a successful weed biocontrol program in a heavily invaded native rangeland?
(A) Permanent desertification of the rangeland due to uncontrolled insect overgrazing
(B) Rapid evolution of high toxicity in all surrounding native grass and shrub species
(C) Restoration of native biodiversity as competitive pressure from weeds declines
(D) Total displacement of native insect populations by the introduced biocontrol agent

2006

47. Zygogramma bicolorata is popularly known as the Mexican beetle. Which invasive terrestrial weed was it successfully introduced to control in India?
(A) Lantana camara
(B) Parthenium hysterophorus
(C) Chromolaena odorata
(D) Ageratum conyzoides

2016

48. Which of the following classic terrestrial weed biocontrol agents is INCORRECTLY paired with its taxonomic order?
(A) Zygogramma bicolorata : Coleoptera
(B) Dactylopius ceylonicus : Hemiptera
(C) Teleonemia scrupulosa : Hemiptera
(D) Cactoblastis cactorum : Hymenoptera

2004

49. The introduction of Dactylopius ceylonicus for the control of Opuntia vulgaris in India is historically significant because:
(A) An early and successful example of classical biological control of a weed
(B) The first instance of using an insect to completely eradicate an aquatic weed
(C) Evidence of the danger of biocontrol agents switching to major agricultural crops
(D) Reliance on the male insects feeding exclusively on the cactus pollen grains

2005

50. Which of the following represents the correct sequence of chronological events in a classical weed biological control program?
(A) Foreign exploration → Host-specificity testing → Mass rearing → Field release
(B) Mass rearing → Field release → Foreign exploration → Host-specificity testing
(C) Field release → Mass rearing → Host-specificity testing → Foreign exploration
(D) Host-specificity testing → Foreign exploration → Field release → Mass rearing

2005

51. In evaluating the success of Zygogramma bicolorata in managing Parthenium, which specific feeding behavior is most relevant to its suppressive impact?
(A) Both adults and larvae feed on leaves and buds, hindering growth and flowering
(B) The larvae bore exclusively into the deep taproot, causing rapid wilting
(C) The adults feed selectively on the pollen, preventing seed set in the plant
(D) The insects induce large galls on the stem that completely block water transport

2021

52. When comparing the mechanisms of control between Dactylopius ceylonicus and Zygogramma bicolorata, which of the following is accurate?
(A) Both insects control their hosts by transmitting lethal phytoplasmas to the sap
(B) Dactylopius feeds by chewing large sections of the plant, while Zygogramma sucks
(C) Both insects act as specialized root borers during their immature larval stages
(D) Dactylopius is a sap-sucker, whereas Zygogramma is a leaf-consuming defoliator

2006

53. If a region has a prolonged, severe winter with heavy frost, which intrinsic limitation of Zygogramma bicolorata would likely eliminate it as an effective, stand-alone biocontrol agent for Parthenium in that specific area?
(A) Its total inability to consume Parthenium seeds produced during the summer
(B) Requirement for warm, humid conditions, often leading to winter diapause
(C) Its strict dependence on a secondary host plant for overwintering survival
(D) Its high susceptibility to native parasitoid wasps during the spring season

2004

54. Neochetina eichhorniae and Neochetina bruchi are key biological control agents utilized globally for the suppression of which notorious aquatic weed?
(A) Salvinia (Salvinia molesta)
(B) Hydrilla (Hydrilla verticillata)
(C) Water hyacinth (Eichhornia crassipes)
(D) Water lettuce (Pistia stratiotes)

2018

55. Arrange the biological sequence of the damage inflicted by Neochetina spp. on water hyacinth in the correct order:
I. Adults create distinct feeding scars on the leaf lamina
II. Fungal pathogens enter through the feeding scars
III. Larvae tunnel through the petioles into the plant crown
IV. The weed loses buoyancy and ultimately sinks
(A) I, II, III, IV
(B) I, III, II, IV
(C) II, I, III, IV
(D) IV, III, II, I

2007

56. Identify the correct statement regarding the biocontrol of Salvinia molesta by Cyrtobagous salviniae.
(A) Larvae mine buds and tunnel into rhizomes, crippling structural integrity
(B) C. salviniae is a massive moth that defoliates the weed entirely at night
(C) C. salviniae is only effective in cold, temperate freshwater lake systems
(D) The biocontrol program for Salvinia molesta is largely considered a failure

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2016

57. Which of the following is a negative consequence or limitation associated with the use of aquatic weed biocontrol agents like Neochetina spp?
(A) Frequent hybridization with native aquatic beetles, creating new invasive pest species
(B) Complete dependence on specific temperature ranges, leading to reduced efficacy in cooler climates
(C) The rapid consumption of native, non-target aquatic flora such as lotuses and water lilies
(D) The production of toxic insect frass that severely pollutes the water column

2004

58. An advantage of using Cyrtobagous salviniae over mechanical harvesting for Salvinia control is:
(A) C. salviniae removes the entire weed mass from the water almost instantly
(B) Continuous, self-sustaining control without ongoing labor and machinery costs
(C) C. salviniae transforms the weed into an edible resource for human consumption
(D) C. salviniae simultaneously purifies the water of heavy metal contaminants

2001

59. The successful establishment and population explosion of Cyrtobagous salviniae in a Salvinia-infested lake typically leads to which cascading environmental effect?
(A) Decay and sinking of the mat, allowing light penetration and native flora return
(B) An increase in the density of the Salvinia mat to compensate for insect damage
(C) A permanent depletion of dissolved oxygen, killing all fish before the weed sinks
(D) Complete evaporation of the water body due to exposed surfaces and sunlight

2015

60. Which of the following statements about aquatic weed biocontrol is INCORRECT?
(A) Neochetina species are weevils belonging to the family Curculionidae
(B) Water hyacinth biocontrol often involves a complex of insects, including moths and weevils
(C) Cyrtobagous salviniae was originally discovered in the arid deserts of Australia
(D) Aquatic weed biocontrol is highly preferred because chemical herbicides can be detrimental to aquatic life

2009

61. In the context of soil ecology, which of the following provides the best definition of bioturbation?
(A) The chemical neutralization of soil acidity by root exudates in the soil
(B) The compaction of topsoil due to the use of heavy agricultural machinery
(C) The complete sterilization of soil microflora through aggressive solarization
(D) Biological reworking, mixing, and aeration of soils by living organisms

2012

62. A farmer notices poor water infiltration and high bulk density in a no-till field. Applying the concept of soil bioturbation, which insect group naturally improves these specific soil properties?
(A) Adult Lepidoptera
(B) Foliage-feeding Chrysomelidae
(C) Subterranean termites and ants
(D) Parasitic Ichneumonidae

2009

63. Which ecological role is correctly paired with the corresponding soil-dwelling insect group?
(A) Subterranean ants : Primary decomposition of fresh mammalian carrion
(B) Subterranean termites : Fragmentation of lignocellulosic material and soil mixing
(C) Termites (Isoptera) : Exclusively predatory on soil nematodes
(D) Collembolans : Aeration of deep subsoil horizons by creating macropores

2008

64. Based on the foraging and nesting activities of subterranean ants, what inference can be made about the soils directly adjacent to large ant colonies compared to surrounding soils?
(A) They have a significantly lower concentration of organic carbon and nutrients
(B) They are completely depleted of beneficial mycorrhizal fungi and bacteria
(C) They are compacted to a brick-like consistency, preventing plant root growth
(D) Enhanced porosity, improved drainage, and higher localized nutrient levels

NODIA

2017

65. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): Termites are often referred to as "ecosystem engineers" in arid and semi-arid tropical savannas.
Reason (R): Termites physically alter the

from simple inorganic molecules in bones
(C) Exclusively consuming hide and hair, leaving soft tissues for vertebrate scavengers
(D) Acting as apex predators that hunt other insects attempting to feed on the carcass

2011

82. The rapid colonization of a fresh animal carcass by blowflies (Calliphoridae) typically results in which effect?
(A) Immediate mummification of the carcass due to total moisture extraction by flies
(B) Complete exclusion of all bacterial and fungal decomposers through competition
(C) Production of maggot masses that generate heat and rapidly liquefy soft tissues
(D) Immediate calcification of the surrounding soil through chemical fly secretions

2024

83. All of the following insect families are ecologically significant as scavengers of dead animal matter EXCEPT:
(A) Pentatomidae
(B) Calliphoridae
(C) Silphidae
(D) Dermestidae

2025

84. In terms of dead organic matter processing, which characteristic makes carrion beetles (Silphidae), particularly burying beetles (Nicrophorus spp.), highly relevant?
(A) Possession of the longest proboscis among insects to suck tissue from a distance
(B) Only processing the remains of invertebrates, ignoring all mammalian carrion
(C) Constructing massive above-ground mounds composed entirely of animal bones
(D) Biparental care by burying small vertebrate carcasses to feed their larvae

2017

85. Consider the following statements about insect scavengers:
I. Maggot masses can elevate the internal temperature of a carcass significantly above ambient temperature.
II. Flesh flies (Sarcophagidae) typically deposit live larvae rather than eggs on a carcass.
III. Carrion feeders play a negligible role in terrestrial carbon and nitrogen cycles.
IV. The arrival of scavenger insects on a carcass is highly random and shows no predictable succession.
V. Scavenging insects can alter the pH and nutrient profile of the soil directly beneath a carcass.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, II and V
(C) II, III and V
(D) I, III and IV

2005

86. Identify the correct statement regarding the succession of insects on carrion.
(A) Dermestid beetles are always the first to arrive at a freshly dead animal carcass
(B) Insect succession terminates once the carcass reaches the active decay stage
(C) Dry stage replacement of blowflies by beetles that feed on skin and cartilage
(D) Sequence of species arrival is chaotic and independent of environmental conditions

2022

87. In forensic entomology, the Post-Mortem Interval (PMI) is primarily estimated by:
(A) Measuring the total blood volume ingested by adult mosquitoes found near the body
(B) Analyzing the concentration of synthetic pesticides in the victim's hair
(C) Counting the total number of adult beetles resting on the soil surface
(D) Determining the age of the oldest developing blowfly larvae present on the corpse

2008

88. A forensic entomologist is calculating the PMI based on blowfly maggot development. If the ambient temperature at the crime scene was abnormally low for several days following death, how must the entomologist adjust the calculation?
(A) Use of degree days to account for slower development at lower temperatures
(B) Decrease in estimated PMI, as low temperatures accelerate maggot growth rates
(C) Application of a mathematical formula based solely on adult fly wingspan size
(D) Total removal of blowfly evidence and reliance only on dermestid beetle data

2008

89. If large numbers of Sarcophagidae larvae are found on a corpse indoors while Calliphoridae are completely absent, what logical inference might a forensic entomologist draw?

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and nitrogen for pasture grasses
(C) Dung beetles only process dung during the freezing temperatures of winter months
(D) Nutrient cycling by dung beetles is restricted to the dung of carnivorous mammals

2016

74. Microarthropods such as collembolans (springtails) and oribatid mites are functionally categorized in soil food webs primarily as:
(A) Primary producers
(B) Detritivores and microbial grazers
(C) Apex predators
(D) Obligate parasites

2011

75. Consider the following statements regarding soil detritivores:
I. Collembolans primarily consume living mammalian tissue.
II. Oribatid mites play a significant role in the fragmentation of leaf litter.
III. Soil microarthropods often graze on fungi and bacteria, regulating microbial populations.
Which of the above statement(s) is/are INCORRECT?
(A) I and III
(B) I and II
(C) I
(D) II

2015

76. When comparing the physical role of earthworms (macrofauna) and collembolans (mesofauna) in litter decomposition, which statement is true?
(A) Collembolans mechanically mix massive volumes of soil, whereas earthworms graze
(B) Both organisms exclusively consume living root hairs for their daily sustenance
(C) Earthworms mix mineral soil, while collembolans fragment litter at a micro-scale
(D) Earthworms are entirely absent in decomposition, a role solely filled by others

2011

77. Which of the following is an INCORRECT pair regarding detritivores and their traits?
(A) Collembola : Possess chewing mouthparts modified to inject venom into prey
(B) Oribatid mites : Often referred to as "beetle mites" with highly sclerotized bodies
(C) Isopoda (Woodlice) : Terrestrial crustaceans that shred decaying leaf litter
(D) Diplopoda (Millipedes) : Macroscopic detritivores contributing heavily to initial litter fragmentation

2015

78. If a researcher aims to completely isolate the decomposition effect of microarthropods (like collembolans and mites) from macroarthropods (like millipedes), which experimental method would best eliminate the macroarthropods?
(A) Exposing the litter bags to continuous ultraviolet radiation
(B) Applying a broad-spectrum fungicide to the leaf litter
(C) Enclosing the leaf litter in mesh bags with pore sizes less than 1 mm
(D) Flooding the soil with concentrated nitrogen fertilizer

2012

79. Collembolans regulate the decomposition rate of leaf litter primarily by:
(A) Secreting strong mineral acids that dissolve leaf cellulose directly in the soil
(B) Grazing on soil fungi, which rejuvenates colonies and speeds enzymatic breakdown
(C) Carrying leaf litter high into the plant canopy to prevent bacterial infection
(D) Producing vast quantities of methane gas that chemically breaks down the leaves

2004

80. Consider the following statements about insect scavengers:
I. Scavenger insects delay the nutrient cycling process by hoarding organic matter.
II. Carrion feeders rely exclusively on living animal hosts for reproduction.
III. Insect scavengers help prevent the spread of diseases by disposing of rotting carcasses.
IV. Silphidae are well-known necrophagous beetles.
Which of the above statement(s) is/are INCORRECT?
(A) I and II
(B) I, II and III
(C) II and IV
(D) I and IV

NODIA

2007

81. In ecological terms, what is the specific role of necrophagous insects in dead organic matter processing?
(A) Accelerating carcass breakdown by consuming flesh and facilitating microbial access
(B) Synthesizing complex organic compounds

(C) Meloidae (Blister beetles)
(D) Coccinellidae (Ladybird beetles)

2001

115. Arrange the biological sequence of allantoin utilization from blowflies in traditional and modern medicine:
I. Extraction or synthetic replication of the active compound
II. Larvae excrete allantoin into the wound as a byproduct of purine metabolism
III. Blowfly larvae are introduced to the wound environment
IV. Allantoin stimulates cellular proliferation and tissue granulation
(A) I, II, III, IV
(B) III, I, II, IV
(C) II, IV, I, III
(D) III, II, IV, I

2005

116. Based on its physiological effect on human tissue, cantharidin is medically classified primarily as a:
(A) Anticoagulant
(B) Analgesic
(C) Vasodilator
(D) Vesicant (blistering agent)

2019

117. What can be directly inferred from the FDA-approved topical use of cantharidin in clinical dermatology?
(A) It is safely ingested in large quantities to treat gastrointestinal parasites
(B) Toxicity is harnessed to destroy benign lesions like warts and molluscum
(C) It is entirely synthetic and has no relationship to blister beetle biology
(D) It is applied broadly across the entire body to promote general skin hydration

2013

118. When comparing the therapeutic applications of allantoin and cantharidin, which statement is true?
(A) Allantoin destroys warts through chemical blistering, while cantharidin heals
(B) Both compounds are exclusively extracted from the hemolymph of adult Lepidoptera
(C) Allantoin promotes healing, while cantharidin is a destructive topical agent
(D) Both compounds act as potent systemic antibiotics when injected intravenously

2023

119. Identify the INCORRECT statement regarding therapeutically active insect biochemicals.
(A) Allantoin is a safe, non-toxic compound widely used in modern cosmetic creams and wound-healing ointments
(B) Male blister beetles synthesize cantharidin and transfer it to females during copulation for egg protection
(C) The consumption of cantharidin-laced insects by livestock (such as horses eating contaminated alfalfa) can result in severe toxicosis and death
(D) Cantharidin is currently the primary first-line oral medication prescribed for chronic hypertension

2013

120. Which of the following traditional insect-derived medicines is correctly paired with its historical use or biological source?
(A) Cochineal extract: Scale insect derivative used as medicinal tincture and dye
(B) Silk fibroin: Extracted from honeybee wax glands for use in orthopedic implants
(C) Weaver ant extracts: Traditionally brewed from termite mounds to treat asthma
(D) Pederin: A soothing skin balm extracted from the hemolymph of blister beetles

2017

121. In various traditional medicinal systems, notably in Asia, specific ant species (like Polyrhachis vicina) are widely consumed as tonics. What is their purported primary medicinal benefit?
(A) To induce deep surgical anesthesia during complex medical procedures
(B) To serve as an immunomodulatory, anti-inflammatory, and anti-aging supplement
(C) To act as a highly effective topical sunscreen against ultraviolet radiation
(D) To dissolve severe blood clots in the brain instantly after a major stroke

2003

122. A biomedical researcher is designing a biodegradable surgical suture. Applying the principles of insect-derived biopolymers, which specific material extracted from Bombyx mori is optimally suited for this purpose?
(A) Chitin from the larval exoskeleton
(B) Silk fibroin from the cocoon
(C) Sericin from the adult moth scales
(D) Meconium from the pupal case

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(A) The body was frozen immediately after death and recently thawed in the room
(B) Barrier access by Sarcophagidae while Calliphoridae were physically excluded
(C) The victim consumed large amounts of insecticidal poisons prior to their death
(D) Sarcophagidae competitively exterminated all Calliphoridae adults within the room

2019

90. Based on their successional colonization in forensic entomology, Piophilidae (cheese skippers) are typically classified under which wave of colonization?
(A) First wave (Fresh stage)
(B) Fourth wave (Advanced decay/butyric fermentation stage)
(C) Second wave (Bloat stage)
(D) Third wave (Active decay stage)

2003

91. Which of the following is a correctly paired insect family with its typical arrival stage in forensic succession?
(A) Silphidae : Active decay stage
(B) Calliphoridae : Dry skeletal stage
(C) Dermestidae : Fresh stage
(D) Sarcophagidae : Dry skeletal stage

2023

92. Identify the INCORRECT statement regarding the application of necrophagous insects in forensic science.
(A) Entomotoxicology involves analyzing insect larvae to detect drugs or toxins present in the victim's tissues
(B) The presence of aquatic insects on a corpse can indicate that the body was submerged in water for a period
(C) Forensic entomology can accurately determine the exact cause of death, such as identifying a specific heart attack
(D) Insects found on a body can indicate if the remains were moved from a rural to an urban environment post-mortem

2015

93. When comparing Calliphoridae (blowflies) and Sarcophagidae (flesh flies) in the context of early carcass colonization, which key biological difference is most relevant?
(A) Calliphoridae adults lack wings, whereas Sarcophagidae are strong, agile fliers
(B) Calliphoridae are strict herbivores, whereas Sarcophagidae are obligate carnivores
(C) Calliphoridae only colonize in darkness, while Sarcophagidae colonize in sunlight
(D) Calliphoridae lay egg masses, whereas Sarcophagidae deposit live maggots

2006

94. What is a primary advantage of utilizing dermestid beetles for museum skeleton preparation over traditional chemical maceration techniques?
(A) Dermestid beetles can clean a skeleton entirely within a few short minutes
(B) The beetles chemically bleach the bones to a perfect white color automatically
(C) Removal of dried flesh from fragile specimens without damaging the bone
(D) The beetles consume the bones and excrete them as perfectly reassembled skeletons

2013

95. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): Dermestes maculatus colonies used in museum taxidermy require strict containment and monitoring.
Reason (R): Dermestid beetles can rapidly multiply and escape, posing a severe threat to natural history collections by destroying preserved skins, feathers, and pinned insect specimens.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019

96. During the preparation of a fragile avian skeleton, taxidermists prefer dermestid beetles because the beetles naturally produce which type of enzymes in their gut to digest dried connective tissues?
(A) Cellulases and ligninases
(B) Amylases and pectinases
(C) Lipases and chitinases
(D) Keratinases and proteases

2013

97. The failure to maintain an optimal temperature (around 25-30°C) and humidity in a dermestid beetle colony used for taxidermy will directly cause:
(A) Reduced larval feeding and prolonged pupation, delaying skeletal cleaning
(B) The beetles to spontaneously metamorphose

NODIA

1. Crucial for understanding innate immunity and dorsal-ventral patterning
2. Sex-linked inheritance and chromosomal mapping
3. Provide highly visible banding patterns for studying gene transcription (puffing)
4. Master regulators of embryonic anteroposterior body patterning

(A) P-2, Q-4, R-3, S-1
(B) P-3, Q-2, R-1, S-4
(C) P-2, Q-3, R-4, S-1
(D) P-1, Q-4, R-2, S-3

2010

131. A major advantage of using Drosophila melanogaster in evolutionary biology and population genetics is:
(A) Short generation time allows rapid observation of evolution over many generations
(B) Its extreme longevity allows the study of a single individual over several decades
(C) Its strictly asexual reproductive mode ensures perfectly identical genetic clones
(D) Its massive size allows for the easy extraction of large volumes of blood samples

2007

132. The discovery of the 'white-eye' mutation in Drosophila melanogaster was critical because it provided the first clear evidence for:
(A) Dominant lethal mutations
(B) Cytoplasmic inheritance
(C) Polygenic quantitative traits
(D) Sex-linked genetic inheritance

2021

133. A toxicologist wishes to study the long-term effects of a novel fumigant pesticide on insect population dynamics in stored grain. Applying knowledge of insect models, which species is best suited for this specific bioassay?
(A) Galleria mellonella
(B) Tribolium castaneum
(C) Drosophila melanogaster
(D) Apis mellifera

2012

134. Which of the following is an INCORRECT pair regarding advanced insect research models?
(A) Tribolium castaneum : Model for population ecology and pesticide resistance
(B) Drosophila melanogaster : Model for neurobiology and circadian rhythms
(C) Galleria mellonella : Model exclusively used for studying aquatic biology and osmoregulation
(D) Manduca sexta : Model for insect neurobiology and flight mechanics

2007

135. Consider the following statements about Tribolium castaneum (Red Flour Beetle):
I. It is an excellent model for studying the biology of stored-product pests.
II. It possesses a fully sequenced genome, aiding in functional genomics through RNA interference (RNAi).
III. It is strictly an obligate carnivore.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I
(D) II

2007

136. Galleria mellonella (Greater Wax Moth) larvae are increasingly used as an alternative in vivo infection model for human pathogens (like Candida albicans or Staphylococcus aureus). What logical inference explains this utility?
(A) Immune similarities with mammals and survival at 37°C allow infection modeling
(B) They have an adaptive immune system identical to mammals, producing antibodies
(C) They are cold-blooded and die if incubated at human body temperature (37°C)
(D) They lack any form of immune defense, guaranteeing 100% mortality upon infection

2007

137. All of the following are reasons why Galleria mellonella is preferred over murine (mouse) models in preliminary immunological research EXCEPT:
(A) They are significantly cheaper to purchase and rear in large numbers
(B) They possess a sophisticated network of lymph nodes and a fully functioning spleen
(C) They raise fewer ethical and regulatory concerns than vertebrate testing
(D) They are large enough to be easily inoculated with precise doses of pathogens using micro-syringes

2001

138. Based on its utility in research, Tribolium castaneum is primarily classified under which insect order?
(A) Lepidoptera

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(B) Royal jelly : Secreted by the wax glands on the abdomen of worker bees
(C) Propolis : Resinous mixture collected by bees from tree buds
(D) Bee pollen : Aggregated by bees using nectar and salivary enzymes

2013

106. A naturopath applies a raw honey dressing to a patient's mild burn wound. The antibacterial efficacy of this treatment is best explained by the application of which scientific concept?
(A) The extreme alkalinity of honey physically burns the bacterial cell walls
(B) High osmolarity dehydrates bacteria, and enzymes produce hydrogen peroxide
(C) The presence of heavy metals in the honey acts as a toxic shield against infection
(D) Honey instantly freezes the wound tissue, halting all biological processes

2013

107. Maggot Debridement Therapy (MDT) primarily utilizes the sterile larvae of which specific insect species?
(A) Lucilia sericata
(B) Musca domestica
(C) Hermetia illucens
(D) Tenebrio molitor

2005

108. The therapeutic effect of Lucilia sericata larvae in chronic wound healing is caused by:
(A) The larvae mechanically biting off healthy tissue to stimulate cell division
(B) The larvae spinning a protective silk cocoon over the wound site surface
(C) Larvae secrete proteolytic enzymes that dissolve only necrotic tissue
(D) The larvae chemically converting dead skin into a synthetic skin graft

2019

109. Which of the following aspects of Maggot Debridement Therapy (MDT) is most relevant to combating modern, multidrug-resistant bacterial infections like MRSA?
(A) The maggots induce a high systemic fever in the patient to kill bacteria thermally
(B) The maggots permanently alter the patient's DNA to express natural antibiotics
(C) The maggots suffocate the bacteria by forming an airtight barrier over the wound
(D) Larval secretions contain antimicrobial peptides that destroy resistant bacteria

2023

110. Which of the following represents the correct sequence of steps involved in clinical Maggot Debridement Therapy (MDT)?
(A) Sterilization of fly eggs → Maggot application to the wound → Wound assessment → Removal of mature maggots
(B) Wound assessment → Sterilization of fly eggs → Maggot application to the wound → Removal of mature maggots
(C) Maggot application to the wound → Removal of mature maggots → Sterilization of fly eggs → Wound assessment
(D) Wound assessment → Maggot application to the wound → Removal of mature maggots → Sterilization of fly eggs

2019

111. All of the following are recognized clinical actions of sterile maggots in MDT EXCEPT:
(A) Debridement of necrotic tissue
(B) Surgical reattachment of severed blood vessels
(C) Disinfection of the wound bed
(D) Stimulation of granulation tissue formation

2011

112. Identify the correct statement regarding the application of MDT.
(A) Maggots are typically left in the wound for three months to complete life cycles
(B) The maggots must be allowed to pupate inside the patient's wound for healing
(C) The larvae used in MDT are harvested directly from wild carrion for strength
(D) MDT is indicated for chronic, non-healing wounds like diabetic foot ulcers

2007

113. A significant advantage of MDT over traditional sharp surgical debridement is:
(A) MDT is selective, removing necrotic tissue while preserving healthy tissue
(B) MDT is a completely painless procedure that requires general anesthesia
(C) MDT permanently cures the underlying diabetic condition causing the ulcer
(D) MDT involves zero psychological discomfort or social stigma for the patient

2009

114. Cantharidin is a highly potent therapeutically active biochemical naturally synthesized by which group of insects?
(A) Cerambycidae (Longhorn beetles)
(B) Carabidae (Ground beetles)

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into a different species of insect
(C) The beetles to suddenly begin consuming the inorganic calcium matrix of bones
(D) The immediate death of all adult beetles due to rapid and severe desiccation

2018

98. Which of the following conditions represents the most appropriate state of a carcass before introducing it to a dermestid beetle colony for skeletonization?
(A) Fresh, bleeding, and heavily saturated with water
(B) Completely submerged in a vat of formaldehyde
(C) Skinned, largely defleshed, and air-dried to a jerky-like consistency
(D) Heavily infested with live blowfly maggots and putrefying liquids

2008

99. All of the following are practical applications or biological traits of Dermestidae EXCEPT:
(A) They possess the rare ability to digest keratin, a primary component of hair and feathers
(B) They are economically important pests of stored animal products, wool, and carpets
(C) They are utilized extensively in forensic entomology to indicate the dry decay stage of a corpse
(D) They actively hunt and predate upon live aphids and scale insects in agricultural fields

2014

100. Match the apitherapy product in List I with its primary active biochemical or clinical application in List II.
List I: Apitherapy product
P. Bee venom
Q. Propolis
R. Royal jelly
S. Beeswax
List II: Active biochemical or clinical application
1. Major lipid source used mostly as a structural and cosmetic base
2. Rich in 10-HDA, utilized for potential anti-aging and vitality properties
3. Contains melittin, utilized for its anti-inflammatory and anti-arthritic effects
4. Contains caffeic acid phenethyl ester (CAPE), highly valued for antimicrobial and wound-healing properties
(A) P-4, Q-3, R-2, S-1
(B) P-3, Q-2, R-4, S-1
(C) P-2, Q-4, R-3, S-1
(D) P-3, Q-4, R-2, S-1

2005

101. Which of the following provides the most accurate definition of apitherapy?
(A) Exclusive use of synthetic chemical compounds to treat bee colony diseases
(B) Medical use of honeybee products for various therapeutic purposes
(C) Psychological treatment of human phobias related to all stinging insects
(D) Genetic engineering of honeybees to produce pharmaceuticals in their nectar

2022

102. Identify the correct statement regarding the biochemical composition and clinical action of bee venom.
(A) Bee venom is primarily composed of complex carbohydrates and neutral lipids
(B) Apamin acts as a powerful central nervous system depressant causing deep sleep
(C) Melittin, the principal active peptide, has antimicrobial properties
(D) Bee venom is completely hypoallergenic and poses no risk of anaphylaxis to users

2003

103. If a patient is highly allergic to tree resins and balsams, which apitherapy product should be immediately eliminated from their treatment plan due to its botanical origin?
(A) Worker bee venom
(B) Royal jelly
(C) Drone brood homogenate
(D) Propolis

2022

104. Royal jelly is a glandular secretion produced by worker bees. What is its specific physiological function within the bee colony?
(A) Fed to queen larvae throughout development to trigger caste differentiation
(B) Used to permanently seal cracks in the hive to prevent cold drafts of air
(C) Primary food source for all adult drones prior to their mating flight period
(D) Applied to the hive entrance to chemically repel all predatory hornet species

2008

105. Which of the following is an INCORRECT pair regarding apitherapy components?
(A) Melittin : Principal cytolytic peptide in bee venom

NODIA

2004

123. All of the following are documented uses of insect derivatives in traditional or modern medicine EXCEPT:
(A) The extraction of pure insulin directly from the venom glands of paper wasps for diabetes management
(B) The use of crushed cochineal insects in traditional remedies for whooping cough
(C) The utilization of silk sericin as a biomaterial for tissue engineering and drug delivery
(D) The consumption of specialized ant extracts to treat rheumatoid arthritis in traditional Chinese medicine

2001

124. The traditional application of live weaver ants (Oecophylla smaragdina) to suture large wounds works by which mechanism?
(A) The ant spins a strong silk thread across the wound, tying it shut naturally
(B) The ant secretes a powerful cyanoacrylate glue from its abdomen to seal tissue
(C) Ant bites the edges together, and the head is severed to lock mandibles
(D) The ant lays eggs in the wound, which physically expand and close the skin gap

2009

125. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): Silk fibroin is extensively utilized in modern biomedicine for tissue engineering scaffolds and drug delivery systems.
Reason (R): Silk fibroin exhibits excellent biocompatibility, tunable biodegradability, and high mechanical tensile strength.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2007

126. Which of the following represents the most appropriate justification for rigorously testing traditional insect-derived medicines through modern clinical trials?
(A) To patent the insects so that local communities cannot utilize them for trade
(B) To prove that all historical medical practices are entirely fraudulent in nature
(C) To isolate active ingredients, standardize dosing, and identify toxicities
(D) To selectively genetically modify the human genome using complex insect DNA

2015

127. If a geneticist is looking for a model organism to study complex vertebrate immunology and the adaptive immune system (involving T-cells and B-cells), which of the following reasons justifies the elimination of Drosophila melanogaster?
(A) D. melanogaster has a prohibitively long generation time for medical studies
(B) D. melanogaster lacks an adaptive immune system, possessing only innate immunity
(C) D. melanogaster is far too difficult to rear in laboratory and climate boxes
(D) D. melanogaster has an excessively large genome, significantly larger than humans

2016

128. In the context of developmental biology, what is a "homeotic mutation" as famously studied in Drosophila melanogaster?
(A) Mutation causing the insect to transition into a pupal state after hatching
(B) Mutation that induces complete sterility in all of the male insect offspring
(C) Mutation that prevents the formation of polytene chromosomes in salivary glands
(D) Mutation transforming one body segment into another, such as legs for antennae

2011

129. Identify the correct statement regarding Drosophila melanogaster as a foundational model organism.
(A) T.H. Morgan research established the chromosomal theory of inheritance
(B) It was primarily used to prove the theory of spontaneous generation of life
(C) It possesses a staggering 46 pairs of chromosomes, identical to the human set
(D) Its genome was fully sequenced only after the human genome project finished

2015

130. Match the significant discovery/concept in List I with its connection to Drosophila melanogaster research in List II.
List I: Significant discovery/concept
P. Thomas Hunt Morgan
Q. Polytene chromosomes
R. Hox genes
S. Toll signaling pathway
List II: Connection to Drosophila melanogaster research

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soil profile by constructing extensive gallery networks and mounds, redistributing clay and organic matter.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2003

66. How do fungus-growing termites (Macrotermitinae) specifically contribute to soil nutrient dynamics?

(A) By synthesizing atmospheric nitrogen directly in their gut without microbial aid
(B) By accumulating toxic heavy metals in their mounds, rendering the soil infertile
(C) By cultivating fungal combs that decompose plant material and enrich soil
(D) By physically preying upon earthworms and extracting their internal nutrients

2006

67. Dung beetles, which play a critical role in pasture nutrient cycling, belong primarily to which taxonomic family?

(A) Scarabaeidae
(B) Carabidae
(D) Staphylinidae
(D) Tenebrionidae

2004

68. The burial of mammalian feces by dung beetles in pasture lands leads to which direct agricultural effect?

(A) An exponential increase in the populations of root-feeding grubs in soil
(B) The permanent loss of nitrogen into the atmosphere via rapid volatilization
(C) The sterilization of the surrounding topsoil due to concentrated uric acid
(D) Suppression of pasture-breeding pest flies and livestock parasites

2009

69. Which of the following best describes the ecological mechanism by which dung beetles suppress gastrointestinal parasites of livestock?

(A) They actively hunt and consume the adult parasitic worms found on the grass
(B) They bury and desiccate dung, depriving parasites of a suitable microhabitat
(C) They secrete highly toxic venom that kills all nematodes in the near vicinity
(D) They act as obligate intermediate hosts, breaking the life cycle of the parasite

NODIA

2009

70. Match the nesting behavior of dung beetles in List I with their corresponding ecological functional group in List II.

List I: Nesting behavior
P. Rollers (form balls of dung and bury them away from the source)
Q. Tunnelers (dig vertical shafts directly beneath the dung pat)
R. Dwellers (live and breed within the dung pat itself)
S. Kleptoparasites (use the dung balls buried by other beetles)

List II: Ecological functional group
1. Endocoprids
2. Paracoprids
3. Telecoprids
4. Inquiline coprophages

(A) P-2, Q-3, R-1, S-4
(B) P-3, Q-1, R-2, S-4
(C) P-3, Q-2, R-1, S-4
(D) P-1, Q-2, R-3, S-4

2006

71. All of the following are benefits of dung beetle activity in agricultural pastures EXCEPT:

(A) Increased soil aeration and water infiltration
(B) Enhanced incorporation of organic matter and nitrogen into the root zone
(C) Reduction in the survivorship of bush flies and buffalo flies
(D) Promotion of pasture fouling, leading to vast areas of unpalatable forage

2009

72. A major disadvantage of using broad-spectrum anthelmintics (like avermectins) in livestock is:

(A) Toxicity of residues to dung beetles, which delays the degradation of dung
(B) They increase the reproductive rate of dung beetles to uncontrollable levels
(C) They cause dung beetles to switch their diet from feces to live plant roots
(D) They completely alter the physical structure of the dung, making it too liquid

2003

73. Identify the correct statement regarding the nutrient cycling role of dung beetles.

(A) Dung beetles exclusively cycle carbon, having no effect on soil nitrogen levels
(B) Facilitating deep incorporation of phosphorus

(B) Coleoptera
(C) Diptera
(D) Hymenoptera

2013

139. The systemic RNA interference (RNAi) response is highly robust in Tribolium castaneum compared to Drosophila. What is the practical effect of this biological trait in research?
(A) It allows "knocking down" specific genes, aiding functional genomics
(B) It renders Tribolium entirely immune to all known viral pathogens in storage
(C) It prevents Tribolium from being used in any genetic sequencing or mapping studies
(D) It causes Tribolium larvae to spin massive quantities of commercial grade silk

2005

140. Consider the following statements about the nutritional profiling of edible insects:
I. Edible insects generally have a lower protein conversion efficiency than beef.
II. The lipid profile of many edible insects is rich in beneficial polyunsaturated fatty acids (PUFAs).
III. Insects contain chitin, which functions as a form of dietary fiber.
IV. Edible insects are typically deficient in essential micronutrients like iron and zinc.
Which of the above statement(s) is/are correct?
(A) I, II and III
(B) I and IV
(C) II and IV
(D) II and III

2019

141. The Protein Efficiency Ratio (PER) of many edible insects, such as crickets, is often reported to be equivalent to or slightly higher than that of:
(A) Pure isolated whey protein typically consumed by professional bodybuilders
(B) Cellulose extracted from woody plants to increase dietary bulk in human diets
(C) Synthetic amino acids completely devoid of nitrogen and other essential atoms
(D) High-quality plant proteins, and comparable to conventional meat and poultry

2022

142. When comparing the environmental footprint of rearing edible insects (entomophagy) to traditional livestock (like cattle), which statement is factually accurate?
(A) Insects require significantly more arable land per kilogram of protein produced
(B) Insects emit vastly larger quantities of greenhouse gases, particularly methane
(C) Insects have a higher feed conversion ratio, requiring less feed for edible mass
(D) Insects require exponentially more fresh water per gram of protein yielded in farms

2013

143. In the context of global malnutrition, which specific nutritional trait makes entomophagy most relevant for populations suffering from anemia?
(A) The high concentration of indigestible chitin in the outer insect exoskeleton
(B) High bioavailability of essential micronutrients, particularly iron and zinc
(C) The complete absence of complex carbohydrates in insect muscle tissue and fats
(D) The presence of toxic cyanogenic glycosides in raw insects gathered from fields

2002

144. Identify the correct statement regarding the lipid profile of edible insects.
(A) Edible insects consist almost entirely of trans-fats, making them dangerous
(B) Insects contain absolutely no cholesterol or sterol precursors in their cells
(C) The lipid content of an insect remains static throughout its developmental stages
(D) Fatty acid composition is diet-dependent and rich in unsaturated fats

2021

145. Consider the following statements regarding entomophagy:
I. Chitin from insect exoskeletons is highly toxic to the human digestive tract.
II. Edible insects typically require a feed conversion ratio of 10:1 (feed to meat).
III. The nutritional profile of an insect is totally unaffected by its developmental stage (larva vs. adult).
IV. Mopane worms are an important source of protein in several African countries.
V. Crickets require roughly the same amount of water as cattle to produce 1 kg of protein.
Which of the above statement(s) is/are INCORRECT?
(A) I, II and IV
(B) II, IV and V
(C) I, III and IV

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ANSWERS

1. (A) Insects that feed on other insects to regulate pest populations
Entomophagous insects play a vital role in agricultural ecosystems by consuming other insects, which helps maintain ecological balance and suppress potential pest outbreaks. This category includes predators that actively hunt prey and parasitoids that develop inside a host. Their presence reduces the need for chemical interventions and promotes sustainable farming practices through the natural regulation of harmful species.

2. (C) Productive insects
Productive insects are defined by their ability to provide commercially valuable materials through their biological processes. Silkworms produce high-quality silk fibers during cocoon formation, while lac insects secrete resinous substances used in various industrial applications. These insects are reared specifically for their economic output, contributing significantly to global trade and providing essential livelihoods for many farming communities worldwide.

3. (A) Pollinators are entirely restricted to the order Hymenoptera in tropical ecosystems
While Hymenoptera contains many important pollinators like bees and wasps, pollination is performed by a wide range of diverse insect orders across all ecosystems. Lepidoptera, Diptera, and Coleoptera also contain numerous species that are essential for plant reproduction. Restricting the definition of pollinators to a single order ignores the complex contributions of other groups to global biodiversity and food security.

4. (D) Ladybird beetles are classified as entomophagous predators
Ladybird beetles are classic examples of entomophagous predators because both the larvae and adults feed extensively on soft-bodied pests such as aphids and scale insects. This predatory behavior makes them invaluable for natural pest suppression. Unlike scavengers or pollinators, their primary ecological function involves the direct consumption of other living insects, thereby reducing the dependency on synthetic chemical pesticides.

5. (A) Both A and R are true and R is the correct explanation of A.
Beneficial insects are indispensable for the stability of agroecosystems because they perform multiple critical functions simultaneously. By regulating pest populations through predation, facilitating the reproductive cycles of crops via pollination, and accelerating the breakdown of organic matter for nutrient cycling, they ensure system resilience. Therefore, their specific functional roles directly explain why they are critical for maintaining balance.

6. (C) Presence of diverse functional groups such as parasitoids and pollinators
A healthy agricultural ecosystem is characterized by functional biodiversity rather than the dominance of a single species or the complete eradication of pests. The coexistence of various groups like pollinators, predators, and parasitoids indicates a robust food web and balanced ecological interactions. This diversity supports natural regulation and enhances the overall productivity and sustainability of the farm through complex biological services.

NODIA

7. (D) Corbicula (pollen basket) : Transport of aggregated pollen to the nest
The corbicula is a specialized morphological structure found on the hind tibiae of many bee species. It is specifically designed to facilitate the transport of large quantities of pollen back to the colony for larval nutrition. This adaptation ensures that bees can efficiently gather and carry floral resources, making them highly effective and specialized pollinators within their respective ecological niches.

8. (A) Construction of elaborate underground galleries to store intact floral structures
While many insects build underground nests, storing intact flowers is not a standard behavioral adaptation for pollination. Instead, successful pollinators exhibit traits like buzz pollination to release trapped pollen, floral constancy to ensure pollen transfer between the same species, and

(D) The complete eradication of the fly from all modern agricultural environments

2017

155. A major advantage of utilizing Black Soldier Fly (BSF) larvae as an alternative aquaculture feed is:
(A) BSF larvae bioconvert organic waste into protein suitable for fish meal
(B) BSF larvae naturally synthesize high levels of astaxanthin, turning fish meat red
(C) BSF adults actively pollinate aquatic plants while laying eggs in the fish ponds
(D) BSF larvae are highly toxic to all known fish parasites, sterilizing the system

2002

156. Based on the biological life cycle of Hermetia illucens, what inference can be made regarding the biosecurity of mass rearing facilities?
(A) Adult BSF are severe vectors of human diseases and require high biosafety levels
(B) BSF larvae aggressively predate upon local native insect populations if they escape
(C) Adults lack mouthparts and are not vectors, posing a negligible nuisance risk
(D) BSF larvae bore into structural timber, threatening the structural integrity

2002

157. Identify the correct statement regarding Tenebrio molitor (yellow mealworms) as alternative livestock feed.
(A) They require a completely liquid diet composed of raw mammalian blood
(B) They are incapable of digesting plant-based carbohydrates from cereal grains
(C) They exhibit a strictly aquatic larval stage, requiring massive water tanks
(D) Efficiently converting dry by-products into protein in space-saving trays

2008

158. In the industrial processing of Black Soldier Fly larvae for poultry feed, the larvae are often fractionated. What are the two primary classifications of the extracted macronutrients?
(A) Chitin and simple sugars
(B) Cellulose and lignin
(C) Defatted protein meal and extracted insect oil/lipids
(D) Nucleic acids and inorganic ash

2012

159. When comparing the mass rearing of Tenebrio molitor (mealworms) and Hermetia illucens (BSF), which statement accurately highlights a distinct rearing dynamic?
(A) Mealworms require hot, tropical environments, whereas BSF require freezing temperatures
(B) BSF consume high-moisture waste, while mealworms are reared on dry substrates
(C) Both species require live vertebrate prey during their final larval instar stages
(D) BSF has a life cycle of several years, whereas mealworms complete it in three days

2024

160. Which of the following is the most appropriate environmental justification for incorporating mealworms and BSF larvae into commercial swine and poultry diets?
(A) It increases the methane output of the livestock, aiding atmospheric processes
(B) It ensures that the livestock will never require any fresh water for drinking
(C) It replaces the need for any complex carbohydrates in the livestock diet
(D) It reduces reliance on fishmeal and soy, mitigating habitat loss and overfishing

****

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(D) I, II, III and V

2025

146. Entomophagy is the technical term for:
(A) The study of insect taxonomy
(B) The biological control of insects using entomopathogenic fungi
(C) The practice of humans consuming insects as food
(D) The evolutionary study of insect-plant coevolution

2008

147. If a global health organization aims to promote insect taxa that are traditionally consumed in mass quantities in Mexico (chapulines), which taxonomic order should they focus on?
(A) Orthoptera
(B) Coleoptera
(C) Lepidoptera
(D) Hemiptera

2012

148. Which of the following major insect taxa consumed globally is correctly paired with its common name and region of high consumption?
(A) Isopterans : Mopane worms (Southern Africa)
(B) Orthopterans : Witchetty grubs (Australia)
(C) Coleopterans : Chapulines (Mexico)
(D) Lepidopterans : Mopane worms (Gonimbrasia belina) (Southern Africa)

2017

149. Identify the INCORRECT statement regarding the human consumption of Isopterans (termites).
(A) They are predominantly consumed during their reproductive swarming phase as alates
(B) Worker termites constitute 99% of the traded market due to their massive size
(C) They are highly valued for their exceptional lipid and protein content levels
(D) They are often harvested using light traps following heavy rains in tropical zones

2021

150. Chapulines, widely consumed in Oaxaca, Mexico, are primarily an edible species of:
(A) Ant
(B) Giant water bug
(C) Grasshopper
(D) Cicada

2005

151. All of the following are potential safety concerns or hazards associated with the wild harvesting of edible insects EXCEPT:
(A) The risk of allergic reactions, particularly in individuals with existing crustacean shellfish allergies (due to cross-reactivity with tropomyosin)
(B) The potential accumulation of heavy metals or agricultural pesticides if harvested from contaminated environments
(C) The presence of anti-nutritional factors or natural toxins in certain brightly colored, chemically defended species
(D) The induction of severe hypervitaminosis C in consumers

2017

152. A community relies heavily on harvesting caterpillars from a specific native forest tree. Applying sustainable entomophagy principles, what is the best strategy to ensure long-term food security?
(A) Implementing semi-cultivation and establishing strict seasonal harvesting quotas
(B) Clearcutting the forest to replace it with intensive cattle grazing pastures
(C) Introducing imported parasitic wasps to increase the larval caterpillar size
(D) Harvesting 100% of the pupae during the overwintering phase in the forest soil

2024

153. The mass harvesting of reproductive termite alates (Isoptera) rather than the workers or soldiers has what effect on the nutritional yield?
(A) It significantly reduces the protein content, as alates are entirely hollow
(B) Exceptionally dense source of energy, as alates are packed with quality lipids
(C) It causes severe toxicity, as alates contain high levels of defensive formic acid
(D) It lowers the caloric value, as alates burn all their fat during flight stages

NODIA

2018

154. What is the primary biological definition of mass rearing dynamics in the context of the Black Soldier Fly (Hermetia illucens)?
(A) The preservation of wild fly specimens for museum collections and display
(B) Controlled cultivation to maximize the total output of larval fly biomass
(C) The genetic engineering of the fly to produce various pharmaceutical proteins

precise timing to match floral openings. These behaviors directly facilitate the fertilization of plants while the insect is foraging.

9. (B) It restricts feeding to deep, tubular corollas, ensuring specialized pollination
The evolution of a specialized long proboscis in sphingid moths represents a highly specific adaptation for accessing nectar in deep, tubular flowers. This relationship creates an exclusive partnership where only certain insects can reach the reward, thereby ensuring high pollination fidelity. Such specialization minimizes resource competition and increases the likelihood that pollen is transferred between compatible and specific plant individuals.

10. (B) P-3, Q-2, R-4, S-1
Different insect groups possess distinct adaptations for pollination. Bumblebees are famous for sonication to release pollen. Honeybees utilize the corbicula on their hind legs for efficient transport. Lepidopterans have specialized scales that can trap and move pollen grains between flowers. Solitary leaf-cutter bees, belonging to the Megachilidae family, use abdominal scopae to collect and carry their pollen loads.

11. (A) Collecting pollen exclusively from a single plant family or genus
Oligolecty is a highly specialized foraging behavior observed in certain solitary bees that limit their pollen collection to a narrow range of related plant species. This strategy ensures that the bees become experts at handling specific floral morphologies, often resulting in high pollination efficiency. It represents a significant evolutionary trade-off between general resource availability and highly specialized foraging and reproductive success.

12. (C) Solitary bees like the alfalfa leaf-cutter bee are more efficient as they reliably trip the alfalfa flower mechanism
In alfalfa crops, honeybees often learn to avoid the "tripping" mechanism of the flower, which can be physically jarring and potentially dangerous. Conversely, specialized solitary bees like the alfalfa leaf-cutter bee are adapted to trigger this mechanism consistently while foraging. This reliable interaction ensures successful pollen transfer, making solitary bees far more effective than honeybees for this specific crop.

13. (D) Bombus terrestris, because tomatoes require sonication to release pollen
Tomato flowers have poricidal anthers that only release pollen when vibrated at specific frequencies. Bumblebees, such as Bombus terrestris, perform a behavior called buzz pollination or sonication, where they vibrate their thoracic muscles to dislodge the pollen effectively. This specialized ability makes them superior to honeybees for greenhouse tomato production, where natural wind and vibration are often insufficient for fertilization.

14. (C) Megachile rotundata: Complex eusocial structure with worker castes
Megachile rotundata, known as the alfalfa leaf-cutter bee, is a solitary species rather than a eusocial one. Unlike honeybees, each female is fertile and constructs her own nest without the help of a worker caste. While they may nest in close proximity to one another in gregarious groups, they do not exhibit the complex social hierarchy or division of labor.

15. (B) I and II
Bumblebees are exceptionally effective in cool climates because they can generate internal heat through shivering, allowing them to forage at low temperatures. Leaf-cutter bees are solitary and use cut leaf fragments to build their brood cells rather than wax. However, honeybees are eusocial insects that remain together in a colony throughout the winter, relying on stored honey for survival.

16. (D) The distance and direction of a rich floral resource relative to the sun
The waggle dance is a sophisticated communication method used by honeybees to recruit nestmates to productive food sources. The angle of the dance relative to gravity indicates the direction of the resource in relation to the sun, while the duration of the waggle phase communicates the distance. This allows the colony to efficiently exploit scattered floral resources in the surrounding environment.

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17. (A) High susceptibility to colony collapse and mites, threatening pollination stability
Managed honeybees face significant threats from pathogens, pesticides, and parasitic mites, which can lead to sudden colony losses. Relying solely on a single species for agricultural pollination creates a vulnerable system that is susceptible

to widespread failure. Diversifying pollinator populations by supporting wild bees can provide a more stable and resilient pollination service, protecting food production from potential biological crises.

18. (C) Providing artificial wooden nesting blocks with pre-drilled holes
Solitary leaf-cutter bees are cavity nesters that naturally utilize hollow stems or abandoned beetle burrows. In agricultural settings where natural nesting sites are often scarce, providing artificial structures like wooden blocks with precisely drilled holes can significantly increase their local population. This management practice encourages these beneficial insects to remain in the area and provides them with secure locations for reproduction.

19. (A) New colonies are founded in the spring by a single overwintered, mated queen
Bumblebee colonies are typically annual, meaning they only last for one growing season. In the spring, a lone queen that has survived the winter emerges to find a nesting site and begins the first brood of workers. As winter approaches, the colony produces new queens and drones, after which the old queen, workers, and drones die, leaving only mated queens.

20. (A) I and III
Honeybees demonstrate age polyethism, where individuals progress from hive cleaning to foraging as they grow older. Bumblebees are well known for utilizing buzz pollination to vibrate and release pollen from specific flowers. However, solitary bees typically use mass provisioning for their larvae, and leaf-cutter bees use leaf pieces rather than wax. These traits highlight the diverse reproductive strategies within Hymenoptera.

21. (B) Mesothoracic pockets
Female fig wasps have evolved specialized anatomical structures known as mesothoracic pockets to carry pollen between syconia. As they emerge from their natal fig, they actively collect pollen and store it in these protected cavities. When they enter a new fig to lay eggs, they retrieve the pollen to fertilize the flowers, ensuring the continued survival of both the wasp and tree.

22. (C) Increased fruit set and yield without the need for manual pollination
The introduction of the weevil Elaeidobius kamerunicus to Southeast Asia revolutionized the oil palm industry by providing a natural and highly efficient pollination service. Previously, plantations relied on expensive and labor-intensive manual pollination methods. The presence of these specialized weevils led to a dramatic increase in fruit set and oil yield, demonstrating the immense economic value of utilizing appropriate biological pollinators.

23. (D) The male wasps fly extensively between different trees to find unfertilized females
Male fig wasps are usually wingless and spend their entire lives inside the syconium where they were born. Their primary roles are to mate with the emerging females and chew exit holes through the tough fig wall to allow the females to escape. Once these tasks are completed, the males die within the fig, never experiencing the outside environment or other trees.

24. (A) Its exclusive feeding and breeding life cycle within male inflorescences
Elaeidobius kamerunicus is perfectly synchronized with the oil palm because it completes its entire life cycle on the male flowers. The weevils feed on the pollen and lay their eggs in the spent male inflorescences. While moving between the male and female flowers to find food or mates, they inadvertently transport large quantities of pollen, making them the primary pollinators.

25. (B) I, III and V
Fig wasps are indeed Hymenopterans, and the interaction with Ficus is an obligate mutualism. Male wasps are wingless and die within the fig. However, oil palm weevils are pollinators, not predators, and they primarily use olfactory cues, such as the strong anise-like scent of the flowers, rather than visual cues to locate their hosts. These distinctions are vital for understanding specialized interactions.

26. (B) Syconium
A syconium is a unique type of inflorescence characteristic of the genus Ficus. It consists of a fleshy, hollow receptacle with numerous small flowers lining the internal walls. Access to these flowers is restricted to a tiny opening called the ostiole. This specialized structure requires a highly specific relationship with fig wasps,

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which are the only insects capable of entering to pollinate.

27. (A) Blowflies (Calliphoridae) are entirely detrimental to crops and play no role in commercial pollination
While often associated with decay, blowflies are actually important pollinators for several plant species and are sometimes used commercially. In confined spaces like greenhouses or isolation cages, they can be more effective and easier to manage than bees. They are particularly useful for pollinating crops with small, shallow flowers that produce nectar easily accessible to their sponging-type mouthparts during foraging.

28. (C) Lepidopterans (Butterflies)
Flowers that emit putrid odors resembling decaying meat are specifically adapted to attract saprophagous insects like blowflies, flesh flies, and carrion beetles. These insects are naturally drawn to such scents for feeding or oviposition. Lepidopterans, such as butterflies, are generally attracted to sweet or floral fragrances and would not be the primary pollinators for plants that utilize mimicry of decay to attract visitors.

29. (D) Diptera
The family Syrphidae consists of the hoverflies or flower flies, which are members of the order Diptera. These insects are easily recognized by their ability to hover motionless in mid-air before darting to flowers. While the adults are important pollinators that feed on nectar and pollen, the larvae of many species are beneficial predators that consume significant numbers of agricultural pests like aphids.

30. (C) Blowflies and hoverflies, as their short mouthparts access shallow nectar
Carrots and onions produce small, clustered flowers with easily accessible nectar, which are ideal for insects with relatively short, unspecialized mouthparts. Dipterans like blowflies and hoverflies are frequently the most abundant and effective visitors for these specific crops. Their foraging behavior and anatomy allow them to move quickly between the shallow floral structures, ensuring high rates of cross-pollination and seed production.

31. (B) Hoverflies (Syrphidae) : Larvae of many species are predatory on aphids
Hoverflies are unique because they provide dual benefits to agriculture. As adults, they are effective pollinators that visit a wide variety of flowering plants. During their larval stage, many species are voracious predators of aphids and other soft-bodied pests. This combination of pollination and biological control makes them highly valuable components of integrated pest management and natural ecosystem service provision.

32. (D) Better adaptation to confined spaces without exhibiting aggressive stinging behavior
In small isolation cages used for plant breeding, honeybees often become stressed and focus on escaping rather than foraging. Blowflies are much better adapted to these confined environments and continue to visit flowers reliably without the risk of stinging researchers. This makes them a practical and cost-effective alternative for ensuring pollination in specialized agricultural research and high-value seed production systems.

33. (A) Butterflies typically land while feeding, whereas hoverflies frequently hover
These two groups exhibit very different foraging styles. Butterflies usually settle on the flower and use their long proboscis to reach nectar while their legs provide stability. Hoverflies, as their name suggests, often remain suspended in the air or make brief, light contact with the floral surface. These different physical interactions with the flower can influence the patterns of pollen deposition and transfer.

34. (C) Drastic reduction in fruit set and overall crop yield
Self-incompatible crops require the transfer of pollen from a different individual to achieve fertilization. Without adequate insect activity to facilitate this cross-pollination, the flowers will fail to develop into fruit. This results in significant economic losses for growers due to low yields and poor-quality produce. Ensuring a robust population of pollinators is therefore essential for the commercial success of many horticultural enterprises.

35. (C) A true but R is false.
Insect cross-pollination is well known to improve the quality, size, and nutritional value of fruits by ensuring full fertilization and seed development.

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However, the reason provided is incorrect because pollinators do not primarily function by repelling pests. Instead, the improved fruit set is a direct result of successful genetic exchange and hormonal triggers that occur within the plant after effective pollination.

36. (D) Ensuring diverse, abundant pollen reaches the stigma, enhancing seed mass
Optimal insect pollination ensures that a high volume and diversity of pollen grains reach the stigma. This leads to more successful fertilization of the ovules within the ovary. The resulting increase in seed number and quality directly influences the development of the surrounding fruit tissue. This process maximizes the xenia effect, leading to heavier seeds and more robust, well-formed fruit.

37. (B) Superior floral fidelity and temporal synchrony with local crop varieties
Native insect pollinators have often co-evolved with local flora, meaning their activity periods and physical traits are perfectly synchronized with the blooming times of native and locally adapted crops. This natural alignment can result in more efficient and reliable pollination compared to honeybees, which may be less active in certain weather conditions or less attracted to specific local floral morphologies.

38. (C) Physical transfer of pollen from staminate flowers to pistillate flowers
In monoecious crops like pumpkins and cucumbers, individual flowers are either male (staminate) or female (pistillate) on the same plant. Since the pollen is relatively heavy and not easily carried by the wind, insects are required to physically move the pollen from the male to the female flowers. This transfer is the critical step that allows for fertilization and the subsequent development of fruit.

39. (D) An increase in the total oil content and seed weight
For oilseed crops, efficient insect pollination leads to better fertilization of the seeds. This results in larger seeds with higher concentrations of stored lipids, which directly increases the economic value of the harvest. Studies consistently show that fields with high pollinator activity produce significantly more oil per hectare than those with poor pollination, highlighting the importance of conserving beneficial insect populations.

40. (A) P-3, Q-2, R-4, S-1
Specific insects are used to control invasive weeds. Zygogramma bicolorata is the Mexican beetle used against Parthenium. Dactylopius ceylonicus is a cochineal insect that targets Opuntia. Neochetina eichhorniae is a specialized weevil for water hyacinth management. Cyrtobagous salviniae is an exceptionally successful beetle used for controlling the invasive water fern, Salvinia molesta. These agents are selected for their high host specificity.

41. (B) Broad polyphagy to ensure the agent survives even if the target weed is eliminated
A fundamental requirement for any biological control agent is high host specificity. An agent must only attack the target weed and be unable to survive or reproduce on non-target plants, especially crops. Broad polyphagy would be extremely dangerous, as the insect could switch to economically important plants once the weed is gone. Success relies on the agent's specialization and ecological fitness.

42. (B) Suppression of vigor by defoliating, mining, or boring into critical tissues
Phytophagous insects control weeds not by instant eradication, but by damaging the plant's structural and physiological integrity. By consuming leaves, mining through stems, or boring into roots, these insects reduce the weed's ability to photosynthesize, compete for resources, and reproduce. Over time, this constant pressure lowers the weed population to manageable levels and allows native vegetation to recover and re-establish.

43. (A) Protection against switching to economically important or native plants
Host-specificity testing is the most critical safety step in classical biological control. It involves exposing the potential control agent to a wide variety of plants to ensure it cannot complete its life cycle on anything other than the target weed. This protocol prevents the accidental introduction of new pests and ensures that the biocontrol agent remains a beneficial tool rather than an ecological threat.

44. (C) Stem borers
Stem borers are insects whose larvae develop inside the stems of plants. By tunneling through these tissues, they disrupt the vascular system, which is responsible for transporting water and

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nutrients. This internal damage often leads to wilting, structural weakness, and a significant reduction in the plant's overall growth and reproductive capacity. This strategy is particularly effective for controlling weeds with robust, upright stems.

45. (D) Integration of multiple agents targeting different parts, such as root feeders
When a single biocontrol agent cannot fully suppress a weed due to the plant's ability to recover from specific types of damage, a multi-agent approach is often required. By introducing insects that attack different parts of the plant, such as the leaves, stems, and roots, the cumulative stress becomes too great for the weed to overcome. This integrated strategy provides more comprehensive and resilient control.

46. (C) Restoration of native biodiversity as competitive pressure from weeds declines
Invasive weeds often form monocultures that exclude native plants and reduce overall biodiversity. When a biocontrol agent successfully suppresses the weed, the competitive pressure is lifted, allowing native species to return to the area. This leads to a more balanced and diverse ecosystem, providing better habitat for local wildlife and restoring the natural ecological processes that were disrupted by the invasion.

47. (B) Parthenium hysterophorus
Parthenium hysterophorus, commonly known as Congress grass, is a highly invasive weed in India that causes agricultural losses and health problems. The Mexican beetle, Zygogramma bicolorata, was introduced to help manage this pest. Both the larvae and adults feed on the leaves and flower buds of Parthenium, significantly reducing its growth and seed production, especially during the peak monsoon season in tropical areas.

48. (D) Cactoblastis cactorum : Hymenoptera
Cactoblastis cactorum is a moth whose larvae are famous for controlling prickly pear cactus. As a moth, it belongs to the order Lepidoptera, not Hymenoptera. This insect is one of the most successful examples of biological control in history, particularly in Australia, where it saved millions of hectares of land from cactus infestation by boring into and destroying the cactus pads.

49. (A) An early and successful example of classical biological control of a weed
The use of Dactylopius ceylonicus to control the drooping prickly pear in India during the mid-19th century is a landmark event in the history of biological control. It demonstrated that an introduced insect could successfully and safely manage a widespread invasive weed. This success paved the way for future biocontrol programs worldwide, highlighting the potential for using natural enemies to solve complex environmental problems.

50. (A) Foreign exploration → Host-specificity testing → Mass rearing → Field release
Classical biological control follows a logical and rigorous sequence of events. It begins with exploring the weed's native range to find natural enemies. These candidates then undergo extensive host-specificity testing in quarantine. If proven safe, the insects are mass-reared to produce large populations, which are finally released into the field to establish and begin controlling the target weed in the new environment.

51. (A) Both adults and larvae feed on leaves and buds, hindering growth and flowering
The effectiveness of Zygogramma bicolorata stems from the fact that both its life stages are active defoliators of the Parthenium plant. By consuming the leaves, they reduce the plant's photosynthetic capacity, and by eating the flower buds, they directly prevent the production of seeds. This dual impact severely weakens the plant and limits its ability to spread, providing significant suppression of weed density.

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52. (D) Dactylopius is a sap-sucker, whereas Zygogramma is a leaf-consuming defoliator
These two biocontrol agents utilize very different feeding mechanisms. Dactylopius ceylonicus is a cochineal insect that uses its piercing-sucking mouthparts to extract sap from the cactus, causing it to wither. Zygogramma bicolorata is a beetle with chewing mouthparts that physically consumes the leaf tissue. Understanding these different modes of action is essential for selecting the most appropriate agent for a specific weed's biology.

53. (B) Requirement for warm, humid conditions, often leading to winter diapause
Zygogramma bicolorata is native to warmer regions and is highly sensitive to temperature.

In areas with cold winters, the beetles enter a period of inactivity or diapause, usually buried in the soil. If the winter is too severe or prolonged, the population may suffer high mortality. This climatic limitation means that the beetle is most effective in tropical and subtropical regions where warm conditions prevail.

54. (C) Water hyacinth (Eichhornia crassipes)
Neochetina eichhorniae and Neochetina bruchi are specialized weevils that have been released in many countries to control water hyacinth. These weevils are highly specific to this weed and cause significant damage through both larval tunneling and adult feeding. Their introduction is a key component of integrated management strategies designed to reduce the density and spread of this highly invasive and problematic aquatic plant.

55. (A) I, II, III, IV
The process of water hyacinth suppression by Neochetina weevils involves several stages. Adult feeding creates scars that weaken the leaves and provide entry points for pathogens. Simultaneously, the larvae tunnel into the petioles and the crown, causing structural damage. This combined stress reduces the plant's health and buoyancy, eventually leading to the decay and sinking of the weed mass, which clears the water surface.

56. (A) Larvae mine buds and tunnel into rhizomes, crippling structural integrity
The weevil Cyrtobagous salviniae is exceptionally effective because its larvae target the most vulnerable parts of the Salvinia plant. By mining the terminal buds and tunneling through the rhizomes, they prevent new growth and cause the entire mat to break apart and sink. This insect has provided spectacular control of Salvinia in many parts of the world, often restoring entire lake ecosystems within a few years.

57. (B) Complete dependence on specific temperature ranges, leading to reduced efficacy in cooler climates
Many aquatic weed biocontrol agents, including Neochetina species, are tropical in origin and require warm temperatures for optimal growth and reproduction. In cooler climates or during winter months, their activity levels drop significantly, which allows the weed to outgrow the damage caused by the insects. This climatic dependency is a major limitation that must be considered when planning biocontrol programs in temperate regions.

58. (B) Continuous, self-sustaining control without ongoing labor and machinery costs
Mechanical harvesting of aquatic weeds is expensive, labor-intensive, and provides only temporary relief as the weeds quickly regrow. In contrast, once a biocontrol agent like Cyrtobagous salviniae is established, it provides permanent, self-sustaining control. The insect population fluctuates naturally with the weed density, providing a long-term and cost-effective solution that does not require constant human intervention or the use of heavy machinery.

59. (A) Decay and sinking of the mat, allowing light penetration and native flora return
When Cyrtobagous salviniae successfully suppresses a Salvinia infestation, the dense mats of the weed begin to die and sink to the bottom. This process opens up the water surface, allowing sunlight to penetrate into the water column. As a result, native aquatic plants can re-establish, and dissolved oxygen levels improve, which helps to restore the overall health and biodiversity of the aquatic ecosystem.

60. (C) Cyrtobagous salviniae was originally discovered in the arid deserts of Australia
Cyrtobagous salviniae was actually discovered in South America, which is the native range of both the weevil and the Salvinia plant. It was later introduced to Australia and other parts of the world for biological control. The idea that an aquatic weevil would be found in a desert is factually incorrect, as these insects are highly adapted to living on and within floating aquatic vegetation.

61. (D) Biological reworking, mixing, and aeration of soils by living organisms
Bioturbation is a critical ecological process where soil-dwelling organisms, such as insects and earthworms, physically manipulate the soil environment. By digging tunnels, moving particles, and incorporating organic matter, these organisms improve soil structure, increase porosity, and enhance the movement of water and gases. This biological activity is essential for maintaining soil health and supporting the growth of plants in both natural and agricultural systems.

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62. (C) Subterranean termites and ants
In no-till fields where mechanical plowing is avoided, subterranean termites and ants act as natural tillers. Their extensive tunneling activities create macropores that significantly improve water infiltration and reduce soil bulk density. These insects help to maintain a loose and well-aerated soil structure, which is vital for root penetration and the overall productivity of the crop without the need for destructive mechanical cultivation.

63. (B) Subterranean termites : Fragmentation of lignocellulosic material and soil mixing
Subterranean termites are key decomposers in many ecosystems, particularly in the tropics. They possess specialized gut microbes that allow them to break down tough lignocellulosic materials like wood and dry grass. During their foraging and nest-building activities, they mix these organic fragments with mineral soil, which enhances nutrient cycling and improves the physical properties of the soil, making them essential ecosystem engineers.

64. (D) Enhanced porosity, improved drainage, and higher localized nutrient levels
The areas surrounding ant colonies are often "hotspots" of biological activity and nutrient concentration. Ant foraging brings organic matter from the surface into the soil, while their tunnels increase aeration and drainage. Additionally, waste products and dead ants accumulate near the nest, leading to higher levels of nitrogen, phosphorus, and potassium. These changes create a more fertile and hospitable environment for many plant species.

65. (A) Both A and R are true and R is the correct explanation of A.
Termites are fundamental to the structure of savanna ecosystems because they are the primary organisms responsible for moving and processing large amounts of soil and organic matter. By building mounds and galleries, they redistribute nutrients and alter the physical landscape, which in turn influences the distribution of plants and other animals. Their role as ecosystem engineers is a direct result of these physical activities.

66. (C) By cultivating fungal combs that decompose plant material and enrich soil
Fungus-growing termites have a unique symbiotic relationship with fungi of the genus Termitomyces. They build special structures called fungal combs using partially digested plant material. The fungi grow on these combs, breaking down complex fibers and making the nutrients more accessible to the termites. This process results in the concentration of nutrients within the termite mounds, which eventually enriches the surrounding soil.

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67. (A) Scarabaeidae
Dung beetles are members of the family Scarabaeidae, which is a large and diverse group of beetles. These insects are ecologically significant because they specialize in utilizing the feces of mammals for food and reproduction. By burying and processing dung, they play a vital role in nutrient cycling, soil improvement, and the suppression of pests and parasites in both natural rangelands and managed agricultural pastures.

68. (D) Suppression of pasture-breeding pest flies and livestock parasites
One of the most important benefits of dung beetle activity is the rapid removal of feces from the soil surface. This process deprives many pest flies and gastrointestinal parasites of the moist environment they need to complete their life cycles. By burying the dung, the beetles significantly reduce the populations of these harmful organisms, which improves the health and productivity of grazing livestock and reduces the need for chemical treatments.

69. (B) They bury and desiccate dung, depriving parasites of a suitable microhabitat
Dung beetles suppress livestock parasites by fundamentally altering the environment where these parasites develop. By breaking up the dung pat and burying it underground, the beetles cause the material to dry out more quickly. This desiccation kills the eggs and larvae of many parasitic worms and flies that require a stable, moist habitat to survive, thereby breaking their reproductive cycle and reducing the infection risk for animals.

70. (C) P-3, Q-2, R-1, S-4
Dung beetles are categorized by their nesting strategies. Telecoprids, or rollers, move dung balls away from the source. Paracoprids, or tunnelers, bury dung directly beneath the pat. Endocoprids, or dwellers, complete their life cycle inside the dung. Inquiline coprophages, or

136. (A) Immune similarities with mammals and survival at 37°C allow infection modeling
Galleria mellonella larvae are highly useful for medical research because they can survive at 37°C, which is human body temperature. This allows researchers to study pathogens that only cause disease at this temperature. Furthermore, their innate immune system includes specialized cells and antimicrobial peptides that function similarly to those in humans. This makes them a valuable and cost-effective screening tool for testing the virulence of different pathogens and the effectiveness of new antimicrobial treatments.

137. (B) They possess a sophisticated network of lymph nodes and a fully functioning spleen
Insects do not have a closed circulatory system or specialized organs like lymph nodes and a spleen, which are characteristic of vertebrate animals. Instead, they have an open system where hemolymph bathes their internal organs. While their immune response is robust and shares many similarities with the human innate immune system, they lack the complex adaptive immune structures found in mice and humans. This is a key difference that researchers must account for when using them.

138. (B) Coleoptera
Tribolium castaneum belongs to the order Coleoptera, which is the group of insects known as beetles. Beetles are characterized by their hardened forewings, called elytra, which protect the functional wings underneath. This order is the largest group of insects and includes many significant agricultural and stored-product pests. Understanding the biology of beetles is essential for developing effective strategies to manage these pests and protect global food supplies from damage and contamination.

139. (A) It allows "knocking down" specific genes, aiding functional genomics
RNA interference (RNAi) is a powerful technique that allows scientists to selectively silence the activity of specific genes. In Tribolium castaneum, this response is particularly strong and can spread throughout the entire body of the insect. This makes it an ideal model for functional genomics, as researchers can easily observe the physical or behavioral changes that occur when a gene is "knocked down," providing valuable insights into the gene's normal role in the insect's development and survival.

140. (D) II and III
Edible insects are recognized as a highly nutritious food source. Their fats are often rich in polyunsaturated fatty acids, which are beneficial for human health. Additionally, their exoskeletons contain chitin, which acts as a valuable form of dietary fiber that can promote gut health. While the nutritional content can vary, many species are also excellent sources of essential minerals and vitamins, making them a viable and sustainable alternative to traditional livestock protein.

141. (D) High-quality plant proteins, and comparable to conventional meat and poultry
The Protein Efficiency Ratio (PER) is a measure of how well a protein source supports growth. Research has shown that the protein found in many edible insects, such as crickets and mealworms, is of very high quality. It contains all the essential amino acids required by humans and is digested and utilized as efficiently as the protein from beef, chicken, or pork. This makes insects an excellent nutritional substitute for conventional animal-based proteins in the human diet.

142. (C) Insects have a higher feed conversion ratio, requiring less feed for edible mass
Insects are exceptionally efficient at converting their food into body mass because they are cold-blooded and do not spend energy maintaining a constant body temperature. This results in a much higher feed conversion ratio compared to cattle or pigs. For example, crickets require significantly less feed than beef to produce the same amount of protein. This efficiency makes insect farming a much more sustainable option for producing high-quality animal protein with fewer resources.

143. (B) High bioavailability of essential micronutrients, particularly iron and zinc
Iron deficiency and anemia are major global health issues, particularly in developing regions. Many edible insects are naturally very high in iron and zinc, and these minerals are often in a form that is easily absorbed by the human body. This high bioavailability makes insects an ideal food for addressing micronutrient deficiencies. Integrating edible insects into local diets can provide a sustainable and low-cost way to improve the nutritional status of vulnerable populations.

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79. (B) Grazing on soil fungi, which rejuvenates colonies and speeds enzymatic breakdown
Collembolans regulate decomposition primarily through their interactions with soil microorganisms. By grazing on fungi, they prevent colonies from becoming senescent, which stimulates the growth of new, active fungal hyphae. This rejuvenation increases the overall rate of enzymatic breakdown of organic matter. Their grazing activity also helps to disperse fungal spores and bacteria throughout the soil, further facilitating the decomposition process across different microhabitats.

80. (A) I and II
Scavenger insects are vital for rapid nutrient cycling because they break down and dispose of carcasses that would otherwise rot slowly. Most scavengers rely on dead, rather than living, animal tissue for their development. Insects like the Silphidae are well-known necrophagous beetles that specialize in this role. By removing carrion, these insects prevent the accumulation of waste and help to suppress the spread of diseases in the environment.

81. (A) Accelerating carcass breakdown by consuming flesh and facilitating microbial access
Necrophagous insects are the primary drivers of animal decomposition. By consuming the soft tissues, they significantly increase the rate at which the carcass is broken down. Their feeding activities also create openings in the skin and muscle, which allows bacteria and fungi to penetrate more deeply and quickly. This combined biological effort ensures that the nutrients stored in the carcass are recycled back into the soil ecosystem as efficiently as possible.

82. (C) Production of maggot masses that generate heat and rapidly liquefy soft tissues
Blowflies are among the first insects to arrive at a fresh carcass. The large number of larvae they produce often form "maggot masses" which, through their collective movement and metabolism, can raise the temperature within the carcass significantly. This heat, combined with the secretion of proteolytic enzymes, leads to the rapid liquefaction and consumption of soft tissues, greatly accelerating the overall rate of decomposition.

83. (A) Pentatomidae
Pentatomidae is a family of insects commonly known as stink bugs, most of which are phytophagous and feed on plant juices. They do not play a role in the scavenging of dead animal matter. In contrast, families like Calliphoridae (blowflies), Silphidae (carrion beetles), and Dermestidae (skin beetles) are all specialized scavengers that are ecologically important for the decomposition and recycling of nutrients from animal carcasses.

84. (D) Biparental care by burying small vertebrate carcasses to feed their larvae
Burying beetles of the genus Nicrophorus are unique among scavengers for their complex social behavior and parental care. A male and female pair will work together to bury a small animal carcass, such as a mouse or bird, to protect it from other scavengers. They then strip the fur or feathers and coat the body with antimicrobial secretions before laying eggs nearby and actively feeding their developing larvae.

85. (B) I, II and V
Maggot masses generate significant internal heat during decomposition, and flesh flies are known for depositing live larvae rather than eggs. These insects also significantly impact the soil environment by releasing nutrients and changing the pH beneath the carcass. Far from being random, the arrival of these insects follows a predictable successional pattern, and they are critical for the cycling of carbon and nitrogen in terrestrial ecosystems worldwide.

86. (C) Dry stage replacement of blowflies by beetles that feed on skin and cartilage
Insect succession on carrion is a predictable process where different groups of insects arrive at different stages of decay. Early stages are dominated by flies that feed on soft, moist tissues. As the carcass dries out, these flies are replaced by beetles, such as dermestids, which possess specialized enzymes that allow them to consume tough materials like skin, hair, and cartilage that other insects cannot digest.

87. (D) Determining the age of the oldest developing blowfly larvae present on the corpse
Forensic entomologists estimate the post-mortem interval by studying the developmental stages of the insects found on a body. Since blowflies are usually the first to arrive, the age of their oldest

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120. (A) Cochineal extract: Scale insect derivative used as medicinal tincture and dye
Cochineal extract is derived from the crushed bodies of female scale insects found on cacti. Historically, it has been used as a vibrant red dye and in various traditional medicines for treating respiratory and other ailments. While its primary use today is as a natural food and cosmetic colorant (carmine), its history as a medicinal product is well-documented in many cultures, demonstrating the multifaceted value of insect-derived substances throughout human history.

121. (B) To serve as an immunomodulatory, anti-inflammatory, and anti-aging supplement
In traditional Chinese medicine, specific ants like Polyrhachis vicina have been consumed for centuries as a general health tonic. They are believed to possess anti-inflammatory and immunomodulatory properties that can help treat conditions like rheumatoid arthritis and boost overall vitality. Modern research has identified various bioactive compounds in these ants, including zinc and amino acids, which may contribute to their historical reputation as a beneficial nutritional and medicinal supplement.

122. (B) Silk fibroin from the cocoon
Silk fibroin is a protein produced by silkworms that is exceptionally well-suited for biomedical applications. It possesses high tensile strength, which is necessary for surgical sutures, and is also biocompatible, meaning it does not cause a strong immune response in the human body. Furthermore, its rate of biodegradation can be controlled, allowing it to provide support for a wound while it heals and then slowly dissolve away as the natural tissue recovers.

123. (A) The extraction of pure insulin directly from the venom glands of paper wasps for diabetes management
Insulin is a hormone produced by the vertebrate pancreas and is not found in the venom of wasps. While wasp venom contains many interesting peptides and proteins with potential medical uses, it is not a source of insulin. Diabetes is managed using insulin produced through recombinant DNA technology or, historically, from the pancreases of livestock. This highlights the importance of distinguishing between real insect-derived products and scientifically inaccurate or speculative claims.

124. (C) Ant bites the edges together, and the head is severed to lock mandibles
This is a fascinating example of traditional medical technology. In some cultures, large ants with powerful mandibles are used as natural surgical staples. The ant is held over a wound and encouraged to bite the skin closed. Once the mandibles have locked the edges together, the ant's body is removed, leaving the head and mandibles in place to hold the wound shut until it heals sufficiently. This provides an effective and readily available field suture.

125. (A) Both A and R are true and R is the correct explanation of A.
Silk fibroin has become a major focus of modern biomaterials research because it combines strength with biological safety. Its ability to be processed into various forms, such as films, scaffolds, or hydrogels, makes it ideal for supporting the growth of new cells in tissue engineering. The reason provided is correct because these specific physical and biological properties are exactly why silk is so valuable for creating advanced medical delivery systems and implants.

126. (C) To isolate active ingredients, standardize dosing, and identify toxicities
While traditional medicines provide a rich source of potential new drugs, they must be rigorously tested using modern scientific methods. Clinical trials are essential to determine which compounds are actually effective, what the safe and effective dosage is, and what side effects may occur. This process allows for the development of standardized, safe, and effective treatments that can be integrated into modern healthcare systems while ensuring the safety and well-being of patients.

127. (B) D. melanogaster lacks an adaptive immune system, possessing only innate immunity
Drosophila melanogaster is an excellent model for many biological processes, but it does not possess an adaptive immune system, which includes specialized cells like T-cells and B-cells that "remember" specific pathogens. Instead, insects rely on a robust innate immune system to defend themselves. While this makes them great for studying innate immunity, researchers focused on the complexities of vertebrate adaptive immunity must use other models, such

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96. (D) Keratinases and proteases
Dermestid beetles have evolved specialized digestive enzymes, including keratinases and proteases, which allow them to break down and digest tough animal proteins. These enzymes are capable of processing materials like dried muscle, skin, and cartilage, which are composed of complex protein structures. This unique biochemical ability is what makes them so effective at cleaning skeletons, as they can consume the very materials that most other decomposers find indigestible.

97. (A) Reduced larval feeding and prolonged pupation, delaying skeletal cleaning
Like all insects, the metabolic rate of dermestid beetles is closely tied to environmental temperature and humidity. If these conditions fall outside the optimal range, the beetles will become less active, their feeding rate will decrease, and their developmental time will increase. This can significantly slow down the process of skeletonization, making the colony less efficient for taxidermy purposes and potentially leading to the growth of mold or other undesirable organisms.

98. (C) Skinned, largely defleshed, and air-dried to a jerky-like consistency
Dermestid beetles are most efficient when working on carcasses that have been properly prepared. They prefer tissues that are dry but not too hard. Fresh, wet meat can lead to the growth of bacteria and foul odors that can harm the beetle colony. By partially defleshing and drying the specimen, the taxidermist ensures that the beetles have access to their preferred food source in a stable environment that promotes rapid and clean skeletonization.

99. (D) They actively hunt and predate upon live aphids and scale insects in agricultural fields
Dermestidae are specialized scavengers of dead animal products and are not known to be predators of agricultural pests like aphids. While they are invaluable for cleaning bones and are significant pests of stored wool and silk, their ecological role is strictly centered on the decomposition of organic matter. They lack the behavioral and morphological adaptations required for active predation on living insects in a field or garden setting.

100. (D) P-3, Q-4, R-2, S-1
Apitherapy utilizes various bee products for medicinal benefit. Bee venom contains melittin for anti-inflammatory purposes. Propolis, rich in caffeic acid phenethyl ester, serves as a powerful antimicrobial agent. Royal jelly, containing 10-HDA, is used for its vitality-enhancing properties. Beeswax acts as a lipid-rich structural base for many pharmaceutical and cosmetic products, proving the versatility of hive-derived substances for both human health and industrial applications.

101. (B) Medical use of honeybee products for various therapeutic purposes
Apitherapy is a branch of alternative medicine that focuses on using products derived from honeybees to treat various health conditions. These products include honey, pollen, propolis, royal jelly, beeswax, and bee venom. Proponents believe that these natural substances possess unique biochemical properties that can promote healing, reduce inflammation, and boost the immune system, though many applications are still being studied through modern clinical research.

102. (C) Melittin, the principal active peptide, has antimicrobial properties
@@@ Bee venom is a complex mixture of proteins and peptides, with melittin being the most abundant and biologically active component. Melittin has powerful antimicrobial and anti-inflammatory effects, which are explored in various medical treatments. While it can cause pain and allergic reactions in many people, its ability to disrupt cell membranes and modulate the immune system makes it a subject of significant interest in pharmacology and modern biomedical research.

103. (D) Propolis
Propolis is a resinous substance that honeybees collect from the buds of trees and other botanical sources. Because it is largely composed of plant resins and balsams, individuals with known allergies to these substances are at a high risk of having a reaction to propolis. This illustrates the importance of understanding the botanical origins of bee products when using them for therapeutic purposes and highlights the need for careful patient screening.

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104. (A) Fed to queen larvae throughout development to trigger caste differentiation
Royal jelly is an extremely nutrient-rich substance secreted by the hypopharyngeal glands of young worker bees. Its primary role in the hive is to act as the sole food source for larvae destined to become queens. This specialized diet triggers physiological and developmental changes that lead to the formation of a fertile queen, demonstrating the powerful role of nutrition in determining the caste and social structure of the colony.

105. (B) Royal jelly : Secreted by the wax glands on the abdomen of worker bees
This is an incorrect pairing because royal jelly is secreted by glands in the head of worker bees, not by wax glands on the abdomen. Beeswax is the product of the abdominal wax glands. Melittin is indeed the main component of venom, propolis is a resinous mixture from plants, and bee pollen is a collection of floral pollen grains mixed with nectar and enzymes by the foraging bees.

106. (B) High osmolarity dehydrates bacteria, and enzymes produce hydrogen peroxide
The antibacterial properties of honey are due to its unique chemical composition. Its very low water content creates a high osmotic pressure that draws water out of bacterial cells, killing them. Additionally, when honey is diluted, the enzyme glucose oxidase produces hydrogen peroxide, which is a powerful disinfectant. These factors, along with a low pH, create a hostile environment for most bacteria, making honey an effective natural wound dressing.

107. (A) Lucilia sericata
Maggot Debridement Therapy specifically uses the sterile larvae of the green bottle fly, Lucilia sericata. This species is preferred because its larvae are necrophagous, meaning they only feed on dead or infected tissue while leaving healthy tissue untouched. This selectivity is essential for safe medical application. The larvae are reared under sterile laboratory conditions to ensure they do not introduce any new pathogens into the patient's wound during treatment.

108. (C) Larvae secrete proteolytic enzymes that dissolve only necrotic tissue
The primary therapeutic action of maggots is biochemical rather than mechanical. The larvae secrete a potent cocktail of proteolytic enzymes that break down and liquefy dead, necrotic tissue. They then ingest this liquefied material, effectively cleaning the wound bed. This selective debridement process is highly efficient and leaves the surrounding healthy tissue intact, which is a significant advantage over many traditional surgical methods used for cleaning chronic wounds.

109. (D) Larval secretions contain antimicrobial peptides that destroy resistant bacteria
Beyond debridement, maggots contribute to healing by actively disinfecting the wound. Their secretions contain several powerful antimicrobial peptides that can kill a wide range of bacteria, including those that have developed resistance to conventional antibiotics, such as MRSA. The larvae also ingest and digest bacteria as they feed, further reducing the microbial load in the wound and helping to overcome persistent infections that are difficult to treat with standard medicine.

110. (B) Wound assessment → Sterilization of fly eggs → Maggot application to the wound → Removal of mature maggots
Maggot therapy follows a structured clinical procedure. It begins with an assessment to ensure the wound is suitable for treatment. Sterile fly eggs are hatched in a laboratory to produce germ-free larvae. These larvae are then applied to the wound in a special dressing that allows them to breathe while containing them. After a few days, once the larvae have matured and cleaned the wound, they are carefully removed and discarded.

111. (B) Surgical reattachment of severed blood vessels
Maggots are highly effective at cleaning wounds, killing bacteria, and stimulating the growth of new tissue, but they cannot perform complex surgical tasks like reattaching blood vessels. Their role is to prepare the wound for healing by removing dead material and reducing infection. While they promote better blood flow to the wound bed through the stimulation of granulation tissue, they do not have any mechanical ability to repair deep structural damage to the vascular system.

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112. (D) MDT is indicated for chronic, non-healing wounds like diabetic foot ulcers
Maggot Debridement Therapy is most commonly used for chronic wounds that have failed to respond to conventional treatments. Diabetic foot ulcers, pressure sores, and venous stasis ulcers are ideal candidates for MDT because they often contain necrotic tissue and are prone to multi-drug resistant infections. The selective debridement and antimicrobial properties of the maggots can help restart the healing process in these difficult-to-treat cases, often preventing the need for more invasive procedures.

113. (A) MDT is selective, removing necrotic tissue while preserving healthy tissue
A major benefit of maggot therapy is its high degree of selectivity. Surgeons often have difficulty distinguishing exactly between dead and living tissue, which can lead to the accidental removal of healthy flesh. Maggots, however, use biochemical cues to target only the dead material. This precision ensures that the maximum amount of healthy tissue is preserved, which is critical for successful healing and minimizing scarring in sensitive areas of the body.

114. (C) Meloidae (Blister beetles)
Cantharidin is a powerful chemical compound produced by beetles in the family Meloidae, commonly known as blister beetles. These insects use the toxin as a defense mechanism against predators. In humans, contact with the chemical causes painful skin blistering. Despite its toxicity, cantharidin has been used in traditional medicine for centuries and is still used today in modern dermatology for the targeted treatment of certain skin conditions like warts and molluscum.

115. (D) III, II, IV, I
The history of allantoin begins with the observation of healing in wounds infested with blowfly maggots. The larvae naturally excrete allantoin as a byproduct of their metabolic processes. This compound was found to stimulate cell growth and tissue repair. Today, allantoin is either extracted or synthesized for use in many pharmaceutical and cosmetic products, representing a successful transition from a natural biological observation to a widely used modern medical and skin-care ingredient.

116. (D) Vesicant (blistering agent)
Cantharidin is biologically classified as a vesicant because of its ability to cause severe chemical blistering upon contact with skin or mucous membranes. It works by interfering with the structural integrity of skin cells, leading to their separation and the formation of fluid-filled blisters. This powerful physiological effect is what makes it both a dangerous toxin when handled improperly and a useful medical tool when applied precisely by trained professionals to destroy specific lesions.

117. (B) Toxicity is harnessed to destroy benign lesions like warts and molluscum
The medical use of cantharidin is based on its ability to cause a controlled chemical burn. In dermatology, a tiny amount of the compound is applied directly to a wart or other skin growth. The resulting blister physically lifts the lesion away from the underlying healthy skin, allowing it to be easily removed or to fall off naturally. This targeted application harnesses the toxin's destructive power for a beneficial therapeutic outcome in clinical settings.

118. (C) Allantoin promotes healing, while cantharidin is a destructive topical agent
These two compounds have very different medical roles. Allantoin is a soothing, non-toxic substance that encourages the growth of new cells and is used to promote the healing of damaged skin. Cantharidin, on the other hand, is a toxic vesicant used to destroy unwanted tissue through chemical blistering. While both are derived from insects, their physiological actions are nearly opposite, with one supporting tissue repair and the other facilitating targeted tissue destruction.

119. (D) Cantharidin is currently the primary first-line oral medication prescribed for chronic hypertension
Cantharidin is extremely toxic if ingested and is never used as an oral medication for hypertension or any other systemic condition. Ingestion can cause severe damage to the urinary tract and gastrointestinal system, and can even be fatal. Its medical use is strictly limited to external, topical applications in dermatology. Any claim that it is a safe oral treatment for high blood pressure is factually incorrect and represents a significant health risk.

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kleptoparasites, use the dung already processed by other beetles. Each group contributes differently to the movement and incorporation of organic matter into the soil.

71. (D) Promotion of pasture fouling, leading to vast areas of unpalatable forage
Pasture fouling occurs when dung sits on the surface, making the surrounding grass unpalatable to livestock. Dung beetles actually prevent this problem by rapidly burying the feces. Their activity increases soil aeration, improves nutrient incorporation, and reduces pest fly populations. Rather than promoting fouling, dung beetles are essential for keeping pastures clean, productive, and fully available for grazing animals, which increases the overall efficiency of land use.

72. (A) Toxicity of residues to dung beetles, which delays the degradation of dung
Many anthelmintics used to treat livestock parasites are excreted in the feces, where they can remain toxic for several weeks. These residues are often lethal to dung beetles or interfere with their reproduction. When beetle populations are suppressed by these chemicals, the dung remains on the surface for longer, leading to increased pasture fouling, higher fly populations, and a significant disruption of natural nutrient cycling processes.

73. (B) Facilitating deep incorporation of phosphorus and nitrogen for pasture grasses
Dung beetles play a crucial role in nutrient cycling by moving nitrogen and phosphorus from the surface into the root zone of plants. This process reduces the loss of nutrients through volatilization and runoff, ensuring that they are available for uptake by grasses. This biological fertilization improves pasture growth and quality, demonstrating the significant economic value of maintaining healthy dung beetle populations in agricultural systems.

74. (B) Detritivores and microbial grazers
Collembolans and oribatid mites are essential components of the soil food web. They function as detritivores by feeding on decaying organic matter and as microbial grazers by consuming fungi and bacteria. These activities help to fragment litter, which increases the surface area for microbial colonization, and regulate the populations of microorganisms, both of which are critical for the efficient decomposition and recycling of nutrients in the soil.

75. (C) I
Collembolans, or springtails, are primarily detritivores and fungal grazers that live in the soil and leaf litter. They do not consume living mammalian tissue; such a trait is characteristic of certain parasitic or necrophagous flies. Oribatid mites and collembolans are both essential for fragmenting litter and regulating soil microorganisms, which facilitates the breakdown of organic matter and the overall health of the soil ecosystem.

76. (C) Earthworms mix mineral soil, while collembolans fragment litter at a micro-scale
Earthworms are macrofauna that are known for their ability to ingest large amounts of soil and organic matter, mixing them together as they move through the profile. Collembolans are smaller mesofauna that specialize in the micro-scale fragmentation of leaf litter. Together, these organisms work across different scales to ensure that organic matter is broken down and incorporated into the soil, facilitating the work of microbial decomposers.

77. (A) Collembola : Possess chewing mouthparts modified to inject venom into prey
Collembolans are not venomous predators; they typically possess simple chewing or piercing-sucking mouthparts suited for feeding on fungi, bacteria, and decaying organic matter. In contrast, oribatid mites have tough, sclerotized bodies, and millipedes are important macroscopic shredders of leaf litter. Isopods are terrestrial crustaceans that also play a significant role in the initial stages of decomposition by breaking down large pieces of plant material.

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78. (C) Enclosing the leaf litter in mesh bags with pore sizes less than 1 mm
Litter bag experiments use different mesh sizes to selectively exclude certain groups of soil organisms based on their physical size. A mesh size of less than 1 mm will allow small microarthropods like collembolans and mites to enter while preventing larger macroarthropods like millipedes and earthworms from accessing the litter. This method allows researchers to quantify the specific contribution of different size classes of organisms to the decomposition process.

as mice or zebrafish, that possess these specific features.

128. (D) Mutation transforming one body segment into another, such as legs for antennae
Homeotic mutations are genetic changes that cause a fundamental shift in the identity of body parts. In Drosophila, a famous example is the Antennapedia mutation, where legs grow in place of antennae on the head. These mutations revealed the existence of master regulator genes that control the overall body plan during development. Studying these mutations has been critical for understanding how genes coordinate the complex process of building a multicellular organism from a single egg.

129. (A) T.H. Morgan research established the chromosomal theory of inheritance
In the early 20th century, Thomas Hunt Morgan and his students used Drosophila melanogaster to prove that genes are located on chromosomes. By observing the inheritance patterns of mutations like white eyes, they showed that certain traits are linked to sex chromosomes. This work was foundational for the modern science of genetics and earned Morgan a Nobel Prize, establishing the fruit fly as one of the most important model organisms in biological research.

130. (C) P-2, Q-3, R-4, S-1
Drosophila research has led to numerous breakthroughs across various fields. T.H. Morgan used them to map genes on chromosomes. Polytene chromosomes in their salivary glands provided a visible way to study gene activity. Hox genes were discovered to regulate the body plan during development. Finally, the study of the Toll signaling pathway in flies provided essential insights into how innate immunity works, which was later found to be remarkably similar in humans.

131. (A) Short generation time allows rapid observation of evolution over many generations
One of the primary reasons Drosophila is such a successful model organism is its incredibly fast life cycle. A single generation can be completed in about ten days. This allows scientists to observe evolutionary changes, the inheritance of traits, and the effects of natural selection over hundreds of generations in a very short period. This speed is a major advantage over larger animals that can take years to produce even a few generations.

132. (D) Sex-linked genetic inheritance
The discovery of the white-eye mutation in a male fruit fly was a turning point in genetics. Morgan noticed that this trait was almost always passed from mothers to sons and appeared much more frequently in males. This pattern perfectly matched the movement of the X chromosome during reproduction. This was the first definitive proof that a specific gene was physically located on a specific chromosome, establishing the foundation for our understanding of sex-linked traits in all animals.

133. (B) Tribolium castaneum
Tribolium castaneum, the red flour beetle, is a significant pest of stored grains and a perfect model for studying population dynamics in storage environments. Because it naturally thrives in these settings, it is the ideal subject for testing the effectiveness and long-term impact of fumigants and other pesticides used to protect stored products. Its well-studied biology and fully sequenced genome make it a powerful tool for understanding how resistance to these chemicals develops over time.

134. (C) Galleria mellonella : Model exclusively used for studying aquatic biology and osmoregulation
Galleria mellonella is the greater wax moth, and its larvae are terrestrial, not aquatic. They are widely used as models for studying human bacterial and fungal infections because their immune system is surprisingly similar to the innate immune system of mammals. They are also used in toxicology and for testing new antimicrobial drugs. Their large size and ease of handling make them a popular alternative to using vertebrate animals in early-stage medical research and drug development.

135. (A) I and II
Tribolium castaneum is a well-established model organism for studying the biology of stored-product pests. It is particularly valuable because its entire genome has been sequenced, which allows researchers to use techniques like RNA interference (RNAi) to "turn off" specific genes and study their function. However, it is not an obligate carnivore; it primarily feeds on grain and other plant-based materials found in storage, which is why it is such a major agricultural pest.

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larvae provides a minimum time since death. By knowing the species and the temperature at the scene, scientists can calculate how long it took for the insects to reach that specific stage of their life cycle.

88. (A) Use of degree days to account for slower development at lower temperatures
Insect development is temperature-dependent; they grow more slowly in cold conditions and faster in warm ones. Degree days are a way of measuring the accumulated heat needed for an insect to reach a certain stage. If the temperature was low, the entomologist must use these calculations to account for the slower growth rate. This ensures a more accurate estimation of the time since death by adjusting for environmental variations.

89. (B) Barrier access by Sarcophagidae while Calliphoridae were physically excluded
Flesh flies (Sarcophagidae) are known for being able to deposit their live larvae through small openings, such as screen mesh or cracks in a window, while blowflies (Calliphoridae) typically need direct access to the body to lay their eggs. If only flesh flies are present, it often suggests that there was a physical barrier that prevented the larger blowflies from reaching the corpse while the smaller, more persistent flesh flies succeeded.

90. (B) Fourth wave (Advanced decay/butyric fermentation stage)
Cheese skippers belong to a group of insects that typically arrive later in the decomposition process. They are attracted to carcasses that have reached the advanced decay stage, where the tissues are undergoing butyric fermentation. Their larvae are famous for their ability to "jump" or skip, which is a defensive behavior. Their presence is a key successional marker used by forensic entomologists to estimate the time since death in older remains.

91. (A) Silphidae : Active decay stage
Carrion beetles (Silphidae) are most commonly found during the active decay stage of a carcass, where they feed on both the decaying flesh and the maggots of other flies. Blowflies and flesh flies are typical of the earlier fresh and bloated stages. Dermestids, however, are characteristic of the final dry skeletal stage, as they are among the few insects capable of digesting the dried skin and connective tissues.

92. (C) Forensic entomology can accurately determine the exact cause of death, such as identifying a specific heart attack
While insects provide invaluable information about the timing and location of death, they cannot usually identify the specific physiological cause of death, such as a heart attack or a stroke. That is the role of a medical examiner or pathologist. However, forensic entomology can help identify if toxins were involved, if the body was moved, or if wounds were present that attracted insects to specific locations.

93. (D) Calliphoridae lay egg masses, whereas Sarcophagidae deposit live maggots
This biological difference is crucial in forensic science. Blowflies must lay eggs that take time to hatch, whereas flesh flies are larviparous, meaning they deposit active, mobile maggots directly onto the source. This allows flesh flies to colonize a carcass almost instantly upon arrival. This trait can also give them a competitive advantage in certain environments where rapid colonization is necessary for survival before the carcass dries or other scavengers arrive.

94. (C) Removal of dried flesh from fragile specimens without damaging the bone
Dermestid beetles are highly valued in museums because they are extremely precise in their feeding. They consume only the soft, dried tissues while leaving the bone completely intact. Traditional chemical or boiling methods can be too aggressive, potentially warping or dissolving fragile bones, especially in small or delicate species. The beetles provide a gentle and natural way to clean skeletons for scientific study and display without compromising structural integrity.

95. (A) Both A and R are true and R is the correct explanation of A.
Dermestid beetles are powerful tools for taxidermy, but they are also significant museum pests. Because they are adapted to eat dried animal matter, they will readily consume preserved specimens like stuffed birds or pinned insects if they escape their enclosure. Strict containment is necessary because their rapid reproductive rate and specialized diet make them a severe threat to the long-term preservation of natural history collections if not carefully monitored.

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144. (D) Fatty acid composition is diet-dependent and rich in unsaturated fats
The lipid profile of an insect is not fixed; it can be significantly influenced by what the insect eats. This allows farmers to "tune" the nutritional value of edible insects by adjusting their feed. Generally, insects are a good source of healthy unsaturated fats, including essential omega-3 and omega-6 fatty acids. This flexibility and high nutritional quality make insects a versatile and health-promoting addition to both human diets and animal feed formulations worldwide.

145. (D) I, II, III and V
Many common beliefs about entomophagy are incorrect. Chitin is not toxic; it is a safe fiber. Insects are much more efficient than 10:1 conversion, often closer to 2:1. Their nutritional profile changes significantly as they grow, with different stages offering different levels of protein and fat. Finally, insects like crickets require vastly less water than cattle. Mopane worms, however, are indeed a critical and traditional protein source in many African countries.

146. (C) The practice of humans consuming insects as food
Entomophagy is the scientific term used to describe the consumption of insects by humans. This practice has been a part of human culture for thousands of years and is still common in many parts of the world today. As the global population grows and the environmental impact of traditional livestock becomes more apparent, entomophagy is being recognized as a potentially important and sustainable solution for providing high-quality protein and nutrients to a hungry world.

147. (A) Orthoptera
Chapulines are a traditional and very popular snack in Mexico, particularly in the state of Oaxaca. They are a species of grasshopper, which means they belong to the order Orthoptera. These insects are harvested from fields, toasted with seasonings, and eaten as a high-protein food. Their widespread use and cultural significance in Mexico highlight the potential for integrating locally available and sustainable insect species into modern food systems to enhance nutrition and food security.

148. (D) Lepidopterans : Mopane worms (Gonimbrasia belina) (Southern Africa)
Mopane worms are the caterpillars of the emperor moth, Gonimbrasia belina, which belongs to the order Lepidoptera. They are a vital and highly valued source of protein and income for millions of people across Southern Africa. These caterpillars are traditionally harvested from Mopane trees, gutted, and dried for long-term storage and trade. Their ecological and economic importance makes them a prime example of the value of sustainable wild-harvested edible insects.

149. (B) Worker termites constitute 99% of the traded market due to their massive size
In the case of termites, it is the reproductive alates, rather than the workers or soldiers, that are the primary target for human consumption. Alates are much larger and are packed with fat and protein to fuel their swarming flights and the founding of new colonies. They are often harvested in large quantities using light traps after heavy rains. Their high energy content and delicious taste make them a highly sought-after seasonal delicacy in many cultures.

150. (C) Grasshopper
Chapulines are a specific type of grasshopper, typically from the genus Sphenarium, that have been a staple of the Mexican diet for centuries. They are often harvested during the summer and fall from agricultural fields. Because they are efficient at converting plants into protein and are abundant in certain regions, they represent an important traditional food source that is now gaining recognition as a sustainable and nutritious alternative to more conventional meats.

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151. (D) The induction of severe hypervitaminosis C in consumers
While insects are highly nutritious, there is no evidence that they cause hypervitaminosis C, as they are not typically a source of excessive amounts of this specific vitamin. However, other concerns are real, such as potential allergies in people who are sensitive to shellfish, the risk of contamination from pesticides or heavy metals in the wild, and the natural toxins found in some species. These risks highlight the importance of careful harvesting and processing of edible insects.

CHAPTER 19
Statistics and Computer Application

2011

1. Which of the following best defines a continuous statistical variable in the context of agricultural data?
(A) A variable capable of assuming any numerical value within a given interval.
(B) A discrete variable that only assumes whole number values from counting processes.
(C) A categorical variable used to classify subjects into distinct groups with no ranking.
(D) A qualitative variable describing physical traits such as plant color or seed shape.

2010

2. If a researcher records the number of tillers per wheat plant, what type of variable is being collected?
(A) Continuous variable
(B) Nominal variable
(C) Discrete variable
(D) Ordinal variable

2019

3. According to Sturges' rule, which formula correctly estimates the optimal number of classes (k) for a frequency distribution given a total number of observations (N)?
(A) $k = 1 + 3.322 \log N$
(B) $k = 1 - 3.322 \log N$
(C) $k = 3.322 + 1 \log N$
(D) $k = 1 + 3.322 \ln N$

2004

4. In a frequency distribution, the frequency density of a class is calculated to adjust for which of the following characteristics?
(A) Variations in the total frequencies observed across different datasets.
(B) Significant skewness observed within the overall distribution of the data.
(C) Presence of extreme outliers located specifically in the lowest class.
(D) Presence of unequal class intervals.

2003

5. When constructing a grouped frequency distribution for continuous data, the exclusive method of classification ensures that:
(A) The lower limit of a class is always excluded from that specific class interval.
(B) The upper limit of a class is excluded and placed in the next class.
(C) Both the upper and lower limits are included together in the same class interval.
(D) There exists a gap of one unit between the upper limit and the next lower limit.

2023

6. Compared to raw data, organizing continuous data into a frequency distribution primarily results in which of the following trade-offs?
(A) A reduction in data processing time at the expense of computational complexity.
(B) An increase in theoretical precision at the expense of practical interpretability.
(C) Increased data summarization at the expense of losing individual identities.
(D) A more accurate calculation of the arithmetic mean at the expense of variance.

2012

7. A histogram is most appropriately used to graphically locate which of the following measures of central tendency?
(A) Arithmetic Mean
(B) Geometric Mean
(C) Median
(D) Mode

2019

8. Which of the following statements regarding an ogive curve is INCORRECT?
(A) A less than ogive is plotted against the lower class boundaries.
(B) The point of intersection of a less than ogive and a more than ogive corresponds to the median of the distribution.
(C) Ogives can be used to estimate percentiles and quartiles of a frequency distribution.
(D) A more than ogive is constructed by plotting cumulative frequencies against the lower class boundaries.

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160. (D) It reduces reliance on fishmeal and soy, mitigating habitat loss and overfishing
Incorporating insect larvae like mealworms and black soldier flies into livestock diets provides a sustainable alternative to traditional feed sources. By replacing fishmeal and soybean meal, insect protein reduces the environmental pressure on marine ecosystems and decreases the demand for large-scale deforestation for soy cultivation. This shift supports global efforts toward more circular and environmentally responsible agricultural production systems, helping to conserve biodiversity and protect critical habitats for future generations.

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(B) 0.85
(C) 0.98
(D) 1.70

2014

34. Identify the INCORRECT statement concerning the axioms and fundamental rules of probability.
(A) The probability of a certain event occurring is always 1.
(B) The sum of probabilities of all elementary events in a sample space is 1.
(C) The probability of any event can range from -1 to 1 inclusive.
(D) The probability of an impossible event is 0.

2022

35. Match the items in List I with the appropriate items in List II.
List I: (Probability Concepts)
P. Independent events
Q. Exhaustive events
R. Complementary events
S. Mutually exclusive events
List II: (Descriptions)
1. Events that together encompass the entire sample space
2. Events whose intersection is an empty set
3. Events where the outcome of one does not affect the other
4. Two mutually exclusive events that are also exhaustive
(A) P-3, Q-1, R-2, S-4
(B) P-1, Q-3, R-4, S-2
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

2022

36. Which of the following is an exception to the general additive law of probability $P(A \cup B) = P(A) + P(B) - P(A \cap B)$?
(A) When events A and B are mutually exclusive.
(B) When the experiment involves continuous sample spaces.
(C) When the events A and B are conditionally dependent.
(D) When events A and B are statistically independent.

2016

37. In a Poisson distribution, if the mean parameter (λ) is known to be 4, what is the variance of this distribution?
(A) 2
(B) 16
(C) 8
(D) 4

2001

38. Which of the following pairs correctly matches a theoretical distribution with its defining parameters?
(A) Normal distribution : μ, λ
(B) Binomial distribution : n, p
(C) Poisson distribution : n, p
(D) Standard Normal distribution : μ, σ^2 (where $\mu \neq 0$)

2022

39. The Poisson distribution is typically utilized as a limiting case of the Binomial distribution under which specific mathematical conditions?
(A) When sample size n is small and probability of success p approaches 0.5.
(B) When sample size n approaches infinity and probability of success p approaches 1.
(C) When $n \, to \, \infty$ and $p \, to \, 0$ such that np is finite.
(D) When sample size n is finite and probability of success p equals variance.

2014

40. Read the following statements regarding the Binomial distribution:
I. It is a discrete probability distribution.
II. The mean is strictly greater than the variance.
III. It requires a fixed number of independent trials.
IV. The probability of success changes from trial to trial.
V. The outcome of each trial is dichotomous.
Which of the above statement(s) is/are correct?
(A) I, II, III and V
(B) I, II and IV
(C) II, III, IV and V
(D) I, IV and V

2013

41. In agricultural entomology, if a researcher is counting the number of rare mutant insects per square meter of a very large field, the random variable is most appropriately modeled by which distribution?
(A) Normal distribution
(B) Poisson distribution
(C) Hypergeometric distribution
(D) Uniform distribution

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2006

9. When constructing a frequency polygon, the class frequencies are plotted against which of the following values?
(A) Lower class limits
(B) Class midpoints
(C) Upper class boundaries
(D) Cumulative frequencies

2021

10. Identify the correct option based on the Assertion (A) and Reason (R) given below.
Assertion (A): A histogram and a multiple bar chart are statistically identical and can be used interchangeably for continuous frequency distributions.
Reason (R): A histogram is a two-dimensional diagram where both the width and the height of the rectangles are proportional to class intervals and frequencies, respectively.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2023

11. In a moderately skewed frequency distribution, the failure of the less than and more than cumulative frequency curves to intersect exactly at the arithmetic mean is caused by:
(A) The property that cumulative frequency curves mathematically intersect at the median, not the mean.
(B) The existence of unequal class intervals disrupting the cumulative symmetry.
(C) The lack of kurtosis adjustments in the plotting of the ogive curves.
(D) The inherent bias in recording data at the upper class boundaries.

2025

12. What valid statistical inference can be drawn about the total area under a frequency polygon constructed from a continuous frequency distribution?
(A) It is exactly equal to the variance of the distribution.
(B) It systematically underestimates the total frequency of the data by half a class interval.
(C) It equals the total area of the corresponding histogram.
(D) It is proportional to the standard deviation of the grouped data.

2006

13. For any given set of distinct positive observations, the mathematical relationship between the Arithmetic Mean (AM), Geometric Mean (GM), and Harmonic Mean (HM) strictly follows:
(A) $AM \leq GM \leq HM$
(B) $HM \geq AM \geq GM$
(C) $AM = GM = HM$
(D) $AM > GM > HM$

2019

14. An agronomist calculates the average rate of fertilizer application across different fields where equal amounts of fertilizer were applied but field sizes varied. The most appropriate measure of central tendency for this rate is:
(A) Arithmetic Mean
(B) Median
(C) Harmonic Mean
(D) Mode

2001

15. Match the items in List I with the appropriate items in List II.
List I: (Properties)
P. Sum of absolute deviations is minimum
Q. Sum of squared deviations is minimum
R. Cannot be determined graphically
S. Appropriate for averaging growth rates
List II: (Measures of Central Tendency)
1. Arithmetic Mean
2. Geometric Mean
3. Median
4. Harmonic Mean
(A) P-1, Q-2, R-3, S-4
(B) P-3, Q-1, R-4, S-2
(C) P-3, Q-2, R-1, S-4
(D) P-1, Q-3, R-4, S-2

2016

16. Which of the following pairs concerning the mathematical properties of the arithmetic mean is correctly matched?
(A) Origin shift - The mean remains entirely unaffected
(B) Scale shift - The mean is altered only by addition, not multiplication
(C) Extreme values - Minimal impact on the final calculated mean
(D) Algebraic sum of deviations - Always equals zero

2014

17. A sample of 40 soil plots yields an average pH of 6.5, and another sample of 60 soil plots yields an

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average pH of 7.5. What is the combined mean pH of all 100 plots?
(A) 7.1
(B) 7.0
(C) 6.9
(D) 7.2

2022

18. If a constant value of 5 is subtracted from each observation in a dataset and then each result is divided by 2, what can be inferred about the new arithmetic mean?
(A) The new mean is equal to the original mean minus 5.
(B) The new mean remains the same because shifting origin and scale cancel out.
(C) The new mean is equal to the original mean minus 5, all divided by 2.
(D) The new mean is equal to half of the original mean minus 2.5.

2011

19. In an asymmetrical, moderately skewed empirical distribution of crop yields, the relationship among mean, median, and mode is best approximated by:
(A) $Mean - Mode = 3(Mean - Median)$
(B) $Mode = 2Median - 3Mean$
(C) $Mode = Mean - 3(Mean - Median)$
(D) $Median = 3Mode - 2Mean$

2022

20. Read the following statements regarding the Median as a positional average:
I. It is heavily influenced by the presence of extreme anomalous values.
II. It divides a ranked dataset into two equal halves.
III. It is mathematically rigid and strictly utilizes every individual observation in its calculation.
Which of the above statement(s) is/are correct?
(A) I and III
(B) II and III
(C) I
(D) II

2019

21. When calculating the median for a grouped frequency distribution, the interpolation formula assumes that:
(A) All observations are clustered precisely at the midpoint of the median class.
(B) The frequencies are uniformly distributed over the interval of the median class.
(C) The lower class boundary of the median class contains exactly half the frequencies.
(D) The class intervals of the entire distribution are strictly uniform.

2018

22. Positional averages like the median and mode are often preferred over mathematical averages in biological data specifically when:
(A) The sample size is extremely small and follow a normal distribution curve.
(B) The dataset strictly requires complex algebraic manipulation in further steps.
(C) Open-end classes or extreme outliers are present in the distribution.
(D) The calculation of standard deviation is the immediate next statistical requirement.

2012

23. Identify the INCORRECT statement regarding the Mode in statistics.
(A) The mode is the value of the variable that occurs most frequently in a dataset.
(B) A distribution may have more than one mode or no mode at all.
(C) The mode can be located graphically using a histogram.
(D) The mode is always mid-point of the modal class in grouped data.

2009

24. Which of the following best explains why positional averages are considered an exception to standard algebraic treatment in statistics?
(A) They cannot be combined using a simple weighted formula for two groups.
(B) They are inherently biased toward the upper quartiles of a dataset.
(C) They require logarithmic transformations prior to computation in all distributions.
(D) They systematically ignore the central values in favor of boundary values.

2007

25. Consider the following statements regarding measures of dispersion:
I. Standard deviation is independent of change of origin but not of scale.
II. Variance is the square root of standard deviation.
III. Coefficient of variation is a relative measure expressed as a percentage.
IV. Mean deviation can only be calculated from the arithmetic mean.
Which of the above statement(s) is/are correct?

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(A) I, II and III
(B) II and IV
(C) I and III
(D) III and IV

2011

26. The Coefficient of Variation (CV) is mathematically defined as:
(A) $\left(\frac{\text{Standard Deviation}}{\text{Mean}}\right) \times 100$
(B) $\left(\frac{\text{Mean}}{\text{Standard Deviation}}\right) \times 100$
(C) $\left(\frac{\text{Variance}}{\text{Mean}}\right) \times 100$
(D) $\left(\frac{\text{Standard Deviation}}{\text{Variance}}\right) \times 100$

2008

27. If an agronomist adds a constant amount of fertilizer (say 10 kg/ha) uniformly to all experimental plots, what inference can be drawn regarding the variance of the resultant crop yields?
(A) The variance of the yields will increase by 10.
(B) The variance of the yields will increase by 100.
(C) The variance of the yields will remain exactly the same.
(D) The standard deviation will remain the same but the variance will increase.

2001

28. Which of the following is a mathematically correct statement regarding absolute measures of dispersion?
(A) The mean deviation is always strictly greater than the standard deviation for any dataset.
(B) Range is considered the most reliable measure of dispersion for open-ended continuous classes.
(C) Variance is mathematically defined as the expected value of the absolute deviations from the median.
(D) Sum of squared deviations is minimum when taken from the arithmetic mean.

2015

29. Two varieties of wheat, V1 and V2, have yield standard deviations of 5 q/ha and 8 q/ha, and mean yields of 40 q/ha and 50 q/ha, respectively. Based on the concept of relative dispersion, which variety is more consistent in yield?
(A) V2, because it has a higher mean yield.
(B) V2, because its variance is greater.
(C) V1, because its CV is lower than that of V2.
(D) V1, because its standard deviation is numerically smaller.

2015

30. Identify the correct option based on the Assertion (A) and Reason (R) given below.
Assertion (A): Standard deviation is universally preferred over mean deviation as a prerequisite for statistical inference.
Reason (R): Standard deviation strictly relies on squared deviations, making it mathematically tractable for further algebraic manipulation such as variance partitioning.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

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2006

31. In fundamental probability theory, two events are defined as mutually exclusive if:
(A) The occurrence of one event statistically ensures the occurrence of the other.
(B) They cannot occur simultaneously in a single trial of a random experiment.
(C) The probability of their intersection is exactly equal to the product of their individual probabilities.
(D) The sum of their individual probabilities is strictly equal to one.

2021

32. For any two events A and B in a sample space where $P(B) > 0$, the conditional probability of A given B, denoted as $P(A|B)$, is mathematically formulated as:
(A) $\frac{P(A \cup B)}{P(B)}$
(B) $\frac{P(A) \times P(B)}{P(A \cap B)}$
(C) $P(A \cap B) \times P(A)$
(D) $\frac{P(A \cap B)}{P(B)}$

2016

33. If the probability of seed germination for crop A is 0.8 and for crop B is 0.9, and the germination events are independent, what is the probability that both seeds will germinate when sown together?
(A) 0.72

152. (A) Implementing semi-cultivation and establishing strict seasonal harvesting quotas
To ensure that the wild harvesting of insects is sustainable over the long term, it is essential to manage the resource carefully. Semi-cultivation involves protecting the host trees and the insect populations to encourage their growth. Setting quotas on how much can be harvested and during which seasons prevents overexploitation and ensures that enough insects survive to reproduce and maintain the population for future years. This balanced approach supports both local nutrition and forest conservation.

153. (B) Exceptionally dense source of energy, as alates are packed with quality lipids
Termite alates are the winged reproductive forms that leave the nest to start new colonies. To survive this perilous journey and provide enough energy to begin a new nest without feeding, their bodies are heavily laden with fats and proteins. This makes them an exceptionally energy-dense and nutritious food source for humans. Harvesting them during their brief swarming periods provides a significant boost of high-quality calories and essential nutrients to local diets.

154. (B) Controlled cultivation to maximize the total output of larval fly biomass
Mass rearing of the Black Soldier Fly (BSF) is a specialized form of insect farming designed to produce large quantities of larvae as efficiently as possible. This involves maintaining controlled environments where temperature, humidity, and diet are optimized to encourage rapid growth and reproduction. The goal is to create a consistent and reliable supply of insect biomass that can be processed into high-quality protein for use in animal feed or other industrial applications.

155. (A) BSF larvae bioconvert organic waste into protein suitable for fish meal
Black Soldier Fly larvae are exceptional at bioconverting various types of organic waste, including food scraps and agricultural by-products, into high-quality protein and fat. This process turns low-value waste into a valuable resource that can replace expensive and environmentally damaging fishmeal in aquaculture. This not only provides a sustainable source of feed but also helps to manage waste and reduce the environmental footprint of both farming and waste disposal systems.

156. (C) Adults lack mouthparts and are not vectors, posing a negligible nuisance risk
One of the major advantages of using Black Soldier Flies in mass rearing facilities is that the adult flies do not have functional mouthparts and do not feed. Because they do not visit food sources or waste in the same way that common houseflies do, they are not known to transmit diseases to humans. This makes them much safer and less of a nuisance to have in and around production facilities and local communities compared to other fly species.

157. (D) Efficiently converting dry by-products into protein in space-saving trays
Yellow mealworms are highly adaptable and can be reared on a variety of dry organic materials, such as wheat bran or oat flour. They are typically grown in stacked trays, which allows for very high production in a small area. This makes them an ideal candidate for vertical farming and urban agriculture. Their ability to convert low-quality dry by-products into a nutritious protein source makes them a sustainable and efficient option for modern food and feed production.

158. (C) Defatted protein meal and extracted insect oil/lipids
When Black Soldier Fly larvae are processed for animal feed, they are often separated into two main products. The first is a protein-rich meal that has had much of the fat removed, making it an excellent high-protein ingredient for poultry and fish diets. The second is the extracted insect oil, which is rich in beneficial fatty acids and can be used as an energy source in animal feed or in various industrial and cosmetic applications.

159. (B) BSF consume high-moisture waste, while mealworms are reared on dry substrates
These two popular insect species have different dietary requirements that influence how they are reared. Black Soldier Fly larvae are excellent for processing wet organic waste, such as food scraps or manure, because they can thrive in high-moisture environments. In contrast, mealworms prefer much drier conditions and are typically grown on grain-based substrates. These different needs allow for the utilization of a wide variety of organic waste streams depending on which insect species is being farmed.

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2024

42. Identify the INCORRECT statement regarding the probability mass functions (PMF) of discrete distributions.

(A) The sum of the PMF over all possible values of the random variable must equal 1.

(B) The PMF of a Poisson distribution strictly requires knowing the total population size N

(C) The PMF of a Binomial distribution involves combination mathematics (${}^{n}C_{x}$).

(D) The PMF provides the probability that a discrete random variable takes exactly a specific value.

2022

43. When comparing the shapes of Binomial distributions for a fixed n, how does the skewness change based on the parameter p?

(A) Symmetrical when $p = 0.5$, positive skew when $p < 0.5$, and negative skew when $p > 0.5$.

(B) The distribution is always symmetrical regardless of p as long as $n > 30$.

(C) The distribution exhibits positive skewness for all values of p except $p = 1$.

(D) The distribution is symmetrical when $p = 0.5$, negatively skewed when $p < 0.5$, and positively skewed when $p > 0.5$.

2025

44. The probability density function (PDF) of a normal random variable X with mean μ and variance σ^2 is given by the formula:

(A) $f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)}{\sigma^2}}$

(B) $f(x) = \frac{1}{2\pi\sigma} e^{-\frac{1}{2}(x-\mu)^2}$

(C) $f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$

(D) $f(x) = \frac{1}{\sigma\pi} e^{-\left(\frac{x-\mu}{2\sigma}\right)^2}$

2016

45. Arrange the following intervals of a Normal distribution in sequential order from the smallest area under the curve to the largest area under the curve.

I. $\mu \pm 1\sigma$

II. $\mu \pm 1.96\sigma$

III. $\mu \pm 2\sigma$

IV. $\mu \pm 3\sigma$

Select the correct sequence from the options below.

(A) II, I, III, IV

(B) I, III, II, IV

(C) IV, III, II, I

(D) I, II, III, IV

2001

46. Which of the following is a fundamental correct statement regarding the properties of a normal curve?

(A) It is bounded, touching the horizontal axis at exactly 3 standard deviations from the mean.

(B) The total area under the standard normal curve is strictly dependent on the variance.

(C) It is bell-shaped and its mean, median, and mode coincide at the center.

(D) It exhibits positive kurtosis and is defined as leptokurtic compared to the t-distribution.

2012

47. The standard normal deviate, conventionally denoted as Z, is mathematically formulated to transform any normal distribution into a standard normal distribution. What are the mean and variance of the Z distribution?

(A) Mean = 1, Variance = 0

(B) Mean = 0, Variance = 1

(C) Mean = 0, Variance = σ^2

(D) Mean = μ, Variance = 1

2025

48. What statistical inference can be derived regarding the points of inflection on a continuous normal probability curve?

(A) They occur precisely at the maximum ordinate, where $x = \mu$.

(B) They indicate the points where the cumulative distribution function equals 1.

(C) They represent the strict limits of the area encompassing 95% of the data.

(D) They are located at one standard deviation from the mean, i.e., $x = \mu \pm \sigma$.

2011

49. Which of the following best explains the asymptotic nature of the normal curve?

(A) The curve approaches the x-axis but never touches it, extending from $-\infty$ to $+\infty$.

(B) The curve flattens completely at approximately 3 standard deviations, touching the x-axis tangentially.

(C) The area under the curve is localized entirely within a finite interval bounded by the range.

(D) The curve's tails cross the x-axis to account for negative probability mass at extreme deviations.

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2022

50. Identify the correct option based on the Assertion (A) and Reason (R) given below.
Assertion (A): The standard normal distribution curve is strictly symmetrical about $Z = 0$.
Reason (R): The normal distribution is frequently used to approximate the binomial distribution for large n.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2017

51. In the theory of sampling, a "sampling frame" is formally defined as:
(A) A list or map of all distinct sampling units in the target population.
(B) The structural methodology used to randomize the selection of subjects.
(C) The calculated boundary of acceptable error within a given statistical test.
(D) The theoretical probability distribution of the selected sample statistic.

2006

52. Which of the following statements factually differentiates a population parameter from a sample statistic?
(A) A parameter is a random variable, whereas a statistic is a fixed but unknown constant.
(B) A parameter is strictly computed using non-probability sampling, while a statistic requires probability sampling.
(C) A parameter describes the precision of a sample, whereas a statistic describes population variance.
(D) A parameter is a fixed constant, while a statistic is a variable calculated from a sample.

2014

53. If a random sample of size 36 is drawn from an agricultural population with a standard deviation of 12 kg, what is the standard error of the sample mean?
(A) 0.33
(B) 2.0
(C) 3.0
(D) 12.0

2001

54. Identify the INCORRECT statement regarding the theoretical concept of a sampling distribution.
(A) It is the probability distribution of a given sample statistic formed from all possible samples of a specific size.
(B) The standard deviation of the sampling distribution is defined as the standard error of the statistic.
(C) The sampling distribution of the mean is perfectly uniform regardless of the sample size.
(D) As sample size increases, the sampling distribution of the mean approaches a normal distribution, per the Central Limit Theorem.

2014

55. Match the items in List I with the appropriate items in List II (assume N is very large, p is population proportion, $q = 1 - p$).
List I: (Sample Statistics)
P. Sample Mean ($\bar{x}$)
Q. Sample Proportion (p)
R. Difference between two independent means
S. Difference between two independent proportions
List II: (Standard Error Formulas)
1. $\sqrt{\frac{pq}{n}}$
2. $\frac{\sigma}{\sqrt{n}}$
3. $\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$
4. $\sqrt{\frac{p_1 q_1}{n_1} + \frac{p_2 q_2}{n_2}}$

(A) P-1, Q-2, R-3, S-4
(B) P-2, Q-3, R-1, S-4
(C) P-1, Q-4, R-2, S-3
(D) P-2, Q-1, R-3, S-4

2018

56. What is the direct statistical effect of significantly increasing the sample size in a random sampling experiment?
(A) It reduces the standard error, thereby increasing the precision of the estimate.
(B) It completely eliminates all non-sampling errors associated with data collection.
(C) It increases the standard deviation of the population, thereby decreasing precision.
(D) It introduces systematic bias into the theoretical sampling distribution.

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2019

57. When comparing sampling error and non-sampling error in large-scale agricultural surveys, which of the following is true?
(A) Non-sampling errors mathematically disappear as the sample size approaches the population size.
(B) Sampling error decreases with sample size, while non-sampling error may increase.
(C) Sampling errors are generally caused by faulty measurement instruments or respondent bias.
(D) Both sampling and non-sampling errors strictly follow the central limit theorem.

2005

58. A sampling technique where the target population is geographically divided into mutually exclusive units, and a random sample of these complete units is surveyed entirely, is classified as:
(A) Stratified Random Sampling
(B) Cluster Sampling
(C) Systematic Sampling
(D) Simple Random Sampling

2002

59. In Simple Random Sampling Without Replacement (SRSWOR) from a finite population of size N, the total number of possible samples of size n is given by:
(A) ${}^{N}C_{n}$
(B) N^{n}
(C) ${}^{n}P_{N}$
(D) n^{N}

2022

60. Read the following statements regarding systematic sampling:
I. It requires selecting a random start and then selecting every k-th element in succession.
II. It is always statistically superior to stratified sampling regardless of population ordering.
III. It can introduce severe bias if there is a periodic trend in the sampling frame.
Which of the above statement(s) is/are correct?
(A) I and III
(B) II
(C) III
(D) I and II

2019

61. Which of the following pairs correctly relates a stratified sampling allocation method with its primary rationale?
(A) Equal allocation - Maximizes the overall variance of the estimated mean.
(B) Neyman allocation - Allocates sample size strictly inversely proportional to stratum size.
(C) Random allocation - Ensures maximum non-sampling error detection.
(D) Optimum allocation - Minimizes variance for a given cost or minimizes cost for variance.

2019

62. Which of the following represents an exception where Cluster Sampling is typically preferred over Simple Random Sampling despite a potential loss in statistical efficiency?
(A) When the intra-class correlation within the clusters is positive and extremely close to 1.
(B) When the population is highly homogeneous across distinct geographical boundaries.
(C) When a complete sampling frame of individual units is unavailable or too costly to compile.
(D) When the research requires absolute minimal variance of the estimator at any cost.

2021

63. What valid mathematical inference justifies the general efficiency of Stratified Random Sampling over Simple Random Sampling (SRS)?
(A) Stratification artificially inflates the degrees of freedom available for error estimation.
(B) It partitions variance so between-stratum variation does not affect the sampling error.
(C) Stratification guarantees that the sample mean is numerically equal to the population mean without error.
(D) It inherently reduces non-sampling errors by randomizing the interviewers across different strata.

2003

64. Under which specific agricultural field condition is systematic sampling most appropriately applied by agronomists?
(A) When estimating crop traits in a highly randomized, patchy disease outbreak.
(B) When the population consists strictly of heterogeneous independent clusters.
(C) When surveying visual traits whose landholdings follow a strongly skewed socio-economic distribution.
(D) When sampling trees in an orchard planted at regular, known spacing intervals.

2014

65. Read the following statements regarding errors in hypothesis testing:

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(D) P-1, Q-4, R-3, S-2

2012

96. Spearman's rank correlation is conceptually most appropriate and correctly applied in which of the following analytical scenarios?
(A) When quantifying the exact mathematical difference between two continuous population variances.
(B) When evaluating the linear relationship between strictly dichotomous binary variables.
(C) When estimating the exact numerical value of a dependent variable from an independent variable.
(D) When the data is ordinal, such as ranking the visual quality of crop phenotypes.

2024

97. If every observation of variable X is multiplied by a constant $a > 0$ and every observation of variable Y is increased by a constant b, what is the mathematically inferred effect on the correlation coefficient r between X and Y?
(A) It is unchanged as r is independent of change of origin and scale.
(B) It strictly increases by a factor of a.
(C) It increases by $a + b$.
(D) It changes its sign but retains its absolute magnitude.

2025

98. When testing the statistical significance of a computed correlation coefficient (r) derived from a random sample of size n, the test statistic strictly follows a t-distribution. What is the correct formula for this t-statistic?
(A) $t = \dfrac{r\sqrt{n-1}}{\sqrt{1-r^2}}$
(B) $t = \dfrac{r}{\sqrt{1-r^2}}$
(C) $t = \dfrac{r\sqrt{n-2}}{\sqrt{1-r^2}}$
(D) $t = \dfrac{\sqrt{1-r^2}}{r\sqrt{n-2}}$

2017

99. The "Least Squares" method for estimating simple linear regression coefficients fundamentally involves finding the line that:
(A) Minimizes the sum of squared vertical deviations of points from the fitted line.
(B) Minimizes the sum of the absolute errors between observed and predicted values.
(C) Maximizes the correlation coefficient between the variables.
(D) Passes perfectly through the origin and the maximum observed data point.

2006

100. Read the following statements concerning the mathematical properties of regression coefficients ($b_{\{yx\}}$ and $b_{\{xy\}}$):
I. Their geometric mean is equal to the correlation coefficient (r).
II. Both regression coefficients must strictly have the same algebraic sign.
III. They are strictly independent of the change of scale but not of origin.
Which of the above statement(s) is/are correct?
(A) II and III
(B) III
(C) I and III
(D) I and II

2013

101. Which of the following strictly factual statements describes the point of intersection of the two independent lines of regression (Y on X, and X on Y)?
(A) They strictly intersect at the origin $(0,0)$.
(B) They intersect at the point defined by the arithmetic means $((\bar{x}, \bar{y}))$.
(C) They intersect at the point representing the standard deviations, $((\sigma_x, \sigma_y))$.
(D) They are fundamentally parallel and do not mathematically intersect unless $r = 0$.

2006

102. In simple linear regression analysis, if the correlation coefficient between crop yield and rainfall is 0.80, the coefficient of determination conceptually dictates that:
(A) 80% of the variance in crop yield is unaccounted for by the regression model.
(B) The slope of the regression line is exactly 0.64.
(C) 64% of yield variation is explained by its linear regression on rainfall.
(D) A 1 mm increase in rainfall causes exactly an 0.80 unit increase in yield.

2017

103. When statistically comparing regression analysis to correlation analysis, which distinguishing characteristic is most fundamental?
(A) Regression only measures strictly non-linear associations, while correlation only measures linear ones.

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statistically dependent on each other.

2013

73. Identify the INCORRECT statement regarding the theoretical assumptions underlying Student's t-test for a single mean.
(A) The parent population from which the sample is drawn must be approximately normal.
(B) The population standard deviation must be mathematically known prior to testing.
(C) The sample observations must be drawn independently of one another.
(D) The test statistic uses the sample standard deviation as an estimate of the population standard deviation.

2012

74. An agronomist measures the nitrogen content of 15 specific soil plots before and immediately after applying a specific biological amendment. Which parametric test is most appropriate to evaluate the mean effect of the amendment?
(A) Two-sample independent Z-test
(B) Paired t-test
(C) Single-sample t-test
(D) F-test for equality of variances

2006

75. Match the items in List I with the appropriate items in List II.
List I: (Parametric Test Situations)
P. Single sample t-test (size n)
Q. Paired t-test (size n pairs)
R. Independent two-sample t-test (sizes n_1, n_2)
S. Z-test for large samples
List II: (Degrees of Freedom)
1. $n_1 + n_2 - 2$
2. $n - 1$
3. Not applicable / utilizes standard normal distribution parameters
4. $n - 1$ (based on number of pairs)
(A) P-2, Q-4, R-1, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-4, Q-3, R-1, S-2
(D) P-2, Q-1, R-4, S-3

2008

76. In an independent two-sample t-test comparing yields of two distinct maize varieties (Var A with $n_1 = 10$ and Var B with $n_2 = 12$), what is the correct conceptual application for calculating the degrees of freedom?
(A) It is the average of the two sample sizes minus one $(11 - 1 = 10)$.
(B) It strictly requires using the smaller sample size minus one $(10 - 1 = 9)$.
(C) It is the sum of observations in both samples minus two $(10 + 12 - 2 = 20)$.
(D) It is mathematically equal to the product of the two sample sizes $(10 \times 12 = 120)$.

2010

77. What is the expected statistical consequence (cause and effect) if the assumption of population normality is severely violated when conducting a small-sample independent t-test?
(A) The variance is automatically minimized, rendering the test artificially highly precise.
(B) The critical t-values become entirely independent of the degrees of freedom.
(C) The test perfectly transitions into an exact non-parametric permutation test.
(D) Designated error levels may not match theoretical values, compromising validity.

2008

78. When comparing the standard normal (Z) distribution to Student's t-distribution graphically, which characteristic is strictly true?
(A) The Z distribution has a significantly lower peak than the t-distribution at all degrees of freedom.
(B) The t-distribution is strongly positively skewed, whereas the Z distribution is symmetrical.
(C) The t-distribution is leptokurtic with heavier tails than the Z distribution.
(D) The variance of the t-distribution is mathematically less than 1, while Z has a variance of exactly 1.

2021

79. In the context of chi-square statistics, the "test for goodness of fit" is formally defined as a procedure to:
(A) Determine if two continuous random variables are linearly correlated.
(B) Test if observed frequencies deviate from a theoretical probability distribution.
(C) Test the homogeneity of variances across multiple independent normal populations.
(D) Assess the significance of the difference between exactly two sample means.

2004

80. Read the following statements regarding the Chi-square (χ^2) distribution:
I. It is a strictly symmetric continuous probability distribution.

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I. Type I error occurs when a true null hypothesis is rejected.
II. The probability of making a Type I error is denoted by β.
III. Type II error occurs when a false null hypothesis is not rejected.
IV. The power of a statistical test is strictly equal to the probability of a Type I error.

Which of the above statement(s) is/are correct?
(A) II and IV
(B) I, II and IV
(C) I and III
(D) III and IV

2008

66. In the context of reporting statistical results, the p-value is best defined as:
(A) The calculated probability that the alternative hypothesis is entirely false.
(B) The predetermined threshold limit below which a researcher accepts the null hypothesis.
(C) The probability of observing a statistic as extreme as computed, given H_0 is true.
(D) The statistical probability of committing a Type II error during a specific test.

2001

67. The level of significance (α) in hypothesis testing factually represents:
(A) The maximum allowable probability of committing a Type I error.
(B) The maximum allowable probability of committing a Type II error.
(C) The strict mathematical boundary for the degrees of freedom.
(D) The exact probability that the test statistic is normally distributed.

2016

68. Which of the following is a mathematically correct statement regarding the power of a statistical test?
(A) The power of a test decreases as the predetermined level of significance (α) is increased.
(B) The power of a test is strictly independent of the actual magnitude of the true parameter difference.
(C) The power of a test mathematically equals $1-\alpha$.
(D) It is defined as $1-\beta$, the probability of correctly rejecting a false null hypothesis.

2012

69. When comparing types of hypotheses, how does a simple hypothesis strictly differ from a composite hypothesis?
(A) A simple hypothesis involves categorical data, while a composite hypothesis involves continuous data.
(B) A simple hypothesis completely specifies all population parameters, whereas a composite does not.
(C) A simple hypothesis contains strictly non-parametric assumptions, unlike a composite hypothesis.
(D) A simple hypothesis is always the alternative hypothesis, while a composite is the null.

2015

70. Identify the correct option based on the Assertion (A) and Reason (R) given below.
Assertion (A): The degrees of freedom for a single sample t-test computing a mean is $n-1$.
Reason (R): Degrees of freedom mathematically represents the probability of committing a Type I error.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2024

71. In hypothesis testing, the application of a one-tailed test instead of a two-tailed test is strictly dictated by:
(A) The assumption that the population variance is entirely unknown.
(B) The sample size being exclusively larger than 30.
(C) The null hypothesis containing an inequality statement.
(D) The alternative hypothesis specifying a directional difference.

2004

72. A large sample Z-test for comparing a sample mean to a population mean factually requires which of the following primary conditions?
(A) The sample size is large ($n > 30$) and the population variance is known.
(B) The sample size is strictly less than 30 and the data is heavily skewed.
(C) The population variance is unknown, and the population distribution is non-normal.
(D) The observations within the sample are

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(A) The two samples can be mathematically dependent or paired.
(B) The parent populations must strictly follow a normal distribution.
(C) The samples must be drawn randomly from the populations.
(D) The observations within each individual sample must be independent of one another.

2002

89. In the context of the Analysis of Variance (ANOVA), the F-test fundamentally functions by conceptually evaluating:
(A) Whether the sum of squares due to treatments is strictly less than zero.
(B) The ratio of the treatment mean square to the error mean square.
(C) The linear correlation between the block effects and the random error.
(D) The direct difference between the highest and lowest treatment means.

2018

90. Identify the correct option based on the Assertion (A) and Reason (R) given below.
Assertion (A): The square of a Student's t-variate with n degrees of freedom follows an F-distribution with 1 and n degrees of freedom.
Reason (R): Both the t-distribution and F-distribution are fundamentally derived from the ratio of standard normal deviates and chi-square distributions.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2003

91. The "Variance Ratio Test" is synonymous in classical statistics with which of the following specific tests?
(A) F-test
(B) Student's t-test
(C) Z-test
(D) Chi-square test

2015

92. An agricultural scientist conducts an F-test to compare the variance in fruit weight between two different mango orchards and finds that the calculated F-value significantly exceeds the critical F-value. What is the correct application of this finding?
(A) Conclude that the mean fruit weights of the two orchards are identical.
(B) Accept the null hypothesis and pool the variances for a subsequent t-test.
(C) Reject the null hypothesis and conclude the orchards have heterogeneous variances.
(D) Conclude that the samples were improperly randomized during data collection.

2001

93. Pearson's product-moment correlation coefficient (r) must always fall strictly within which of the following mathematical limits?
(A) $0 \leq r \leq 1$
(B) $-\infty < r < +\infty$
(C) $-1 < r < 0$
(D) $-1 \leq r \leq 1$

2016

94. Identify the INCORRECT statement regarding the theoretical interpretation of simple correlation.
(A) A correlation coefficient of exactly zero implies the strict absence of any linear relationship.
(B) Correlation mathematically measures the degree and direction of a linear relationship between two variables.
(C) A significant correlation coefficient strictly proves a causal relationship exists.
(D) A strong negative correlation coefficient indicates that as one variable increases, the other decreases.

2019

95. Match the items in List I with the appropriate items in List II.
List I: (Theoretical Correlation Coefficient Value)
P. $r = +1$
Q. $r = -1$
R. $r = 0$
S. $0 < r < 1$
List II: (Scatter Diagram Pattern)
1. Points perfectly form a straight line sloping downwards
2. Points perfectly form a straight line sloping upwards
3. Points show a random, widely dispersed pattern with no clear trend
4. Points form a distinct upward band but do not lie perfectly on a single line
(A) P-1, Q-2, R-3, S-4
(B) P-2, Q-1, R-3, S-4
(C) P-2, Q-3, R-1, S-4

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(B) I, II, III, IV
(C) II, IV, I, III
(D) IV, II, I, III

2012

111. In the mathematical formulation of Analysis of Variance (ANOVA), how is a "Random Effects Model" formally classified relative to a "Fixed Effects Model"?
(A) In a Random model, the treatments are deliberately chosen by the experimenter, while in Fixed, they are random.
(B) In a Random model, treatments are a sample from a larger population.
(C) In a Random model, the block sizes vary randomly, whereas Fixed models require strictly equal block sizes.
(D) In a Random model, the error variance is strictly zero, unlike the Fixed model.

2017

112. The fundamental factual principle underlying the Analysis of Variance (ANOVA) is the mathematical partitioning of:
(A) The total population degrees of freedom into strictly multiplicative components.
(B) The grand mean into independent sample means.
(C) The probability of Type I error into distinct partial error rates for each treatment.
(D) The Total Sum of Squares into non-overlapping sources of variation.

2016

113. Identify the INCORRECT statement regarding the theoretical assumptions required for performing an Analysis of Variance (ANOVA).
(A) Parent population variances must be heterogeneous for a significant F-ratio.
(B) The parent populations from which the samples are drawn should be normally distributed.
(C) The experimental errors must be independently distributed.
(D) The various treatment and environmental effects must strictly be additive in nature.

2023

114. When conceptually applying the ANOVA framework, what is the critical difference in the Expected Mean Squares (EMS) between a one-way Fixed model and a one-way Random model?
(A) In the Fixed model, the EMS for treatments contains a variance component, while the Random model strictly contains a sum of squared constants.
(B) The EMS for the error term is strictly zero in the Fixed model but non-zero in the Random model.
(C) The Fixed model EMS contains fixed squared effects; the Random model EMS contains treatment population variance.
(D) There is absolutely no mathematical difference in the EMS formulations between the two models.

NODIA

2009

115. If the assumption of homogeneity of variances is severely violated in an agricultural dataset containing percentage counts (e.g., disease incidence between 0% and 100%), what is the most appropriate conceptual application to proceed with ANOVA?
(A) Apply an arcsine transformation to the data prior to the ANOVA.
(B) Discard all zero values and proceed with the standard ANOVA.
(C) Convert the data into ordinal ranks and calculate a strictly linear regression.
(D) Multiply all observations by their respective variances to forcefully stabilize them.

2007

116. Match the specific ANOVA components in List I with their strictly corresponding Degrees of Freedom formula in List II for a standard experiment with t treatments and r replications per treatment.
List I: (ANOVA Components)
P. Total Degrees of Freedom
Q. Treatment Degrees of Freedom
R. Error Degrees of Freedom (for a completely randomized setup)
S. Block Degrees of Freedom (if arranged in blocks)
List II: (Degrees of Freedom Formula)
1. $t-1$
2. $r-1$
3. $tr-1$
4. $t(r-1)$
(A) P-2, Q-3, R-1, S-4
(B) P-3, Q-1, R-2, S-4
(C) P-1, Q-4, R-2, S-3
(D) P-3, Q-1, R-4, S-2

2011

117. Post-hoc multiple comparison procedures (like LSD or DMRT) are factually permitted to be executed strictly under which condition?
(A) Only when the ANOVA F-test fails to reject

(B) Correlation explicitly assumes a unidirectional cause-and-effect relationship, while regression does not.
(C) Regression always requires strictly categorical independent variables, while correlation requires continuous variables.
(D) Correlation measures interdependence, whereas regression determines dependence form.

2017

104. If the computed correlation coefficient (r) between two variables is heavily negative, what strict conceptual application applies to the regression coefficient $b_{\{yx\}}$?
(A) It must strictly be negative, mirroring the direction of the relationship.
(B) It must strictly be positive, as slopes cannot be mathematically negative.
(C) It must strictly fall between 0 and 1.
(D) It becomes statistically insignificant regardless of sample size.

2019

105. Read the following statements regarding multiple and partial correlation in a three-variable system (X_1, X_2, X_3):
I. Multiple correlation measures the combined influence of two or more independent variables on a dependent variable.
II. Partial correlation measures the relationship between two variables while completely ignoring the existence of any other variables.
III. The partial correlation coefficient $r_{\{12.3\}}$ represents the correlation between X_1 and X_2 after removing the linear effect of X_3.
IV. The multiple correlation coefficient is mathematically denoted by R.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II, III and IV
(C) I, III and IV
(D) I and IV

2006

106. The mathematical limits of the multiple correlation coefficient (R) are strictly defined as:
(A) $-\infty < R < +\infty$
(B) $0 \leq R \leq 1$
(C) $-1 \leq R \leq 1$
(D) $-1 \leq R \leq 0$

2022

107. The fundamental meaning of computing a partial correlation coefficient in agricultural field studies is to:
(A) Assess the pure relationship between two variables by holding others constant.
(B) Estimate the missing data points in a partially completed randomized block design.
(C) Provide a strict lower bound for the standard error of the multiple regression estimate.
(D) Partition the sums of squares in a two-way ANOVA table without interaction terms.

2003

108. In the general matrix notation for fitting a multiple linear regression model $Y = X\beta + \varepsilon$, the least squares estimator for the coefficient vector β is factually given by:
(A) $\beta = (XX')^{-1} Y$
(B) $\beta = (X'Y)^{-1} X$
(C) $\beta = (X'X)^{-1} X'Y$
(D) $\beta = X'(X'X)^{-1} Y$

2014

109. Which of the following is considered an exception to the valid application of multiple linear regression analysis (i.e., a severe violation of its assumptions)?
(A) The error terms (ε) follow a normal distribution with a mean of strictly zero.
(B) The variance of the error terms is constant across all levels of the independent variables (homoscedasticity).
(C) The sample size is significantly larger than the number of predictor variables included in the model.
(D) Presence of perfect linear relationship (multicollinearity) among predictors.

2009

110. Arrange the typical procedural steps for constructing and fitting a multiple linear regression model in the correct sequence.
I. Estimate the regression parameters (β) using the least squares method.
II. Define the dependent variable and identify the relevant independent predictor variables.
III. Conduct diagnostic checks for assumptions such as multicollinearity and homoscedasticity.
IV. Test the overall significance of the fitted model using an ANOVA F-test.
Select the correct sequence.
(A) II, I, IV, III

NODIA

treated identically.
(D) The strictly predictable deviation caused by known soil fertility gradients.

2023

125. The principle of "Local Control" is conceptually applied in agricultural experiments primarily to:
(A) Ensure every treatment strictly has an equal chance of being assigned to any plot.
(B) Increase the mathematical degrees of freedom available for treatment effects.
(C) Determine the exact optimal dosage of a pesticide under controlled laboratory conditions.
(D) Isolate known variability sources from error to increase precision.

2019

126. Identify the strictly INCORRECT statement concerning the principle of replication in experimental designs.
(A) Replication provides the mathematical means to estimate the experimental error variance.
(B) Increasing the number of replications generally decreases the standard error of the treatment mean.
(C) Replication and sample size are statistically synonymous in all designs.
(D) Replication helps to average out the unmeasured effects of extraneous variables across experimental units.

2019

127. What is the direct cause-and-effect statistical consequence of increasing the number of replications in an agricultural field experiment?
(A) It strictly decreases the degrees of freedom associated with the experimental error.
(B) It reduces the standard error of the mean, increasing precision.
(C) It causes the total sum of squares to conceptually approach zero.
(D) It inherently reduces the actual physical soil heterogeneity of the experimental field.

2025

128. Match the items in List I with the appropriate items in List II.
List I: (Fundamental Principles)
P. Randomization
Q. Replication
R. Local Control
List II: (Primary Statistical Functions)
1. Provides a valid estimate of experimental error
2. Reduces the magnitude of experimental error variance
3. Ensures the estimate of experimental error is statistically unbiased
(A) P-1, Q-2, R-3
(B) P-2, Q-3, R-1
(C) P-3, Q-1, R-2
(D) P-1, Q-3, R-2

2016

129. The Completely Randomized Design (CRD) is fundamentally defined as an experimental design most suitable strictly for:
(A) Homogeneous experimental units, such as laboratory environments.
(B) Highly heterogeneous field plots with multidirectional soil fertility gradients.
(C) Situations where treatments require vastly different physical plot sizes.
(D) Surveys involving geographically isolated clusters of farmers.

2006

130. Arrange the following conceptual steps for generating the physical layout of a Completely Randomized Design (CRD) with 4 treatments (A, B, C, D) replicated 3 times each.
I. Count the total number of experimental units required ($N = 4 \times 3 = 12$).
II. Assign the treatments to the randomly drawn units until each treatment hits its replication quota.
III. Identify and strictly demarcate 12 homogeneous experimental units.
IV. Use a random number table or generator to draw units from 1 to 12 without replacement.
Select the correct sequence.
(A) I, II, III, IV
(B) III, I, IV, II
(C) I, III, II, IV
(D) I, III, IV, II

2011

131. In the standard ANOVA table for a Completely Randomized Design (CRD), the total variation is mathematically partitioned strictly into which of the following sources?
(A) Treatments and Experimental Error
(B) Blocks, Treatments, and Error
(C) Rows, Columns, Treatments, and Error
(D) Main-plots, Sub-plots, and Error

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the null hypothesis, indicating identical means.
(B) Only after the overall ANOVA F-test for treatments has been found mathematically significant.
(C) Strictly prior to the calculation of the ANOVA table to prevent data snooping.
(D) Whenever the researcher wishes, strictly independent of the ANOVA F-test results.

2021

118. In experimental statistics, the Least Significant Difference (LSD) is strictly defined as:
(A) The maximum allowable variance within any single treatment block.
(B) The largest mathematical difference observed between two block means.
(C) The minimum difference needed between two means for significance.
(D) The difference between the grand mean and the error mean square.

2005

119. When comparing Fisher's Least Significant Difference (LSD) test to Duncan's Multiple Range Test (DMRT), which of the following comparative statements is true?
(A) DMRT strictly uses a single critical difference value for all comparisons, while LSD uses multiple values based on rank distance.
(B) LSD strictly controls the family-wise error rate better than DMRT when the number of treatments is extremely large.
(C) DMRT is mathematically identical to LSD but strictly applies a logarithmic transformation.
(D) LSD is less conservative and more prone to Type I errors than DMRT.

2017

120. Read the following procedural steps regarding the application of Duncan's Multiple Range Test (DMRT):
I. Arrange all sample treatment means in descending or ascending order.
II. Calculate the standard error of the mean ($S_{\bar{x}}$).
III. Multiply $S_{\bar{x}}$ by strictly one universal critical tabular value for all pairs.
IV. Compare the calculated differences between ranked means against the respective significant ranges.
V. Ignore the ANOVA F-test completely before starting.
Which of the above statement(s) is/are correct?
(A) III and V
(B) I, II and IV
(C) II and III
(D) I and V

2010

121. To mathematically compute the Least Significant Difference (LSD) for comparing two treatment means with equal replications (r), a researcher correctly applies which of the following formulas?
(A) $LSD = F_{\alpha} \times \sqrt{\frac{MSE}{r}}$
(B) $LSD = t_{\frac{\alpha}{2}, error_df} \times \sqrt{\frac{2 \times MSE}{r}}$
(C) $LSD = Z_{\alpha} \times \sqrt{\frac{MSE}{2r}}$
(D) $LSD = t_{\alpha} \times \left(\frac{MSE}{r}\right)^2$

NODIA

2004

122. What valid statistical inference drives the necessity of using procedures like DMRT over repeated independent t-tests for all pairs of means?
(A) Repeated independent t-tests drastically deflate the individual comparison error rate.
(B) Repeated t-tests rapidly inflate the family-wise Type I error rate.
(C) Repeated t-tests cannot be computed mathematically if the sample means are negative.
(D) DMRT inherently fixes the violation of normality that t-tests suffer from.

2019

123. The three fundamental principles of experimental design, formally introduced by R.A. Fisher, are strictly identified as:
(A) Randomization, Replication, and Local Control
(B) Stratification, Standardization, and Simplification
(C) Randomization, Normalization, and Independence
(D) Replication, Blocking, and Orthogonality

2022

124. In the theory of design of experiments, "experimental error" is most accurately formally defined as:
(A) The mathematical mistake made by the researcher during manual data entry.
(B) The deliberate variation introduced by assigning different fertilizer levels.
(C) Inherent variation in responses among units

II. Its mathematical range is strictly from $-\infty$ to $+\infty$.
III. The mean of a χ^2 distribution is equal to its degrees of freedom (n).
IV. The variance of a χ^2 distribution is equal to $2n$.
V. It is used to test the independence of attributes in categorical data.

Which of the above statement(s) is/are correct?
(A) III, IV and V
(B) I, II and IV
(C) I and II
(D) II, III and V

2010

81. For an agricultural survey containing categorical data structured in a contingency table with r rows and c columns, the degrees of freedom for the chi-square test of independence are calculated as:
(A) $(r-1)(c-1)$
(B) $r \times c - 1$
(C) $r + c - 2$
(D) $(r-1)+(c-1)$

2014

82. In a 2×2 contingency table analysis, Yates' correction for continuity is most appropriately applied under which specific statistical condition?
(A) When the total sample size exceeds 500, to prevent inflation of the chi-square value.
(B) When there are more than three categories in either the rows or columns.
(C) When the expected frequency in any individual cell of the table falls below 5.
(D) When testing the goodness of fit for a continuous normal distribution.

2004

83. Which of the following pairs correctly represents a fundamental mathematical property of the Chi-square statistic?
(A) The sum of independent chi-square variates is also a chi-square variate.
(B) Multiplicative property - The product of two independent chi-square variables is a chi-square variable.
(C) Scale invariant - Its value remains unchanged if all frequencies are multiplied by a constant.
(D) Negative bounds - It accommodates negative expected frequencies by squaring them.

2024

84. If a chi-square test of independence yields a calculated value of 0.05, what inference is mathematically drawn assuming a typical critical value of 3.84 ($\alpha = 0.05$, 1 df)?
(A) The two attributes are significantly dependent on each other.
(B) The observed frequencies perfectly mirror the variance of the sample.
(C) Yates' correction was inappropriately omitted from the initial calculation.
(D) There is no significant evidence to reject the null hypothesis of independence.

2007

85. Arrange the following procedural steps for computing a Chi-square test of goodness of fit in the correct sequence.
I. Compute the expected frequencies based on the theoretical assumption.
II. Define the null and alternative hypotheses.
III. Calculate the test statistic using $\sum \frac{(O-E)^2}{E}$
IV. Compare the calculated value with the critical value to draw a conclusion.

Select the correct sequence.
(A) I, II, III, IV
(B) II, I, III, IV
(C) II, III, I, IV
(D) I, III, II, IV

2012

86. The F-statistic used to test the equality of two population variances is mathematically computed as:
(A) The arithmetic difference between the two sample variances.
(B) The product of the two sample standard deviations.
(C) The ratio of the two sample variances, with the larger variance in the numerator.
(D) The absolute difference between the sample means divided by the pooled standard deviation.

2021

87. Which of the following is a statistically correct statement regarding the theoretical range of the F-distribution?
(A) It strictly ranges from -1 to $+1$.
(B) It strictly ranges from $-\infty$ to $+\infty$.
(C) It strictly ranges from 1 to $+\infty$.
(D) It strictly ranges from 0 to $+\infty$.

2006

88. Which of the following constitutes an exception to the strict assumptions required for the valid application of an F-test for variances?

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2019

132. For a Completely Randomized Design (CRD) involving t treatments and a total of N experimental units, the degrees of freedom strictly associated with the experimental error conceptually equal:
(A) $N-1$
(B) $t-1$
(C) $(N-1)(t-1)$
(D) $N-t$

2005

133. Which of the following is a mathematically correct statement regarding the handling of missing data in a Completely Randomized Design (CRD)?
(A) Missing data renders the entire CRD statistically invalid, requiring a complete repetition of the experiment.
(B) ANOVA is calculated using unequal replications and adjusted N.
(C) Missing data must strictly be estimated using the geometric mean of the remaining blocks.
(D) The error degrees of freedom remain strictly unchanged even if a plot is missing.

2024

134. When statistically comparing CRD with other designs, what strictly defines its relative efficiency limitation in field conditions?
(A) It artificially restricts randomization strictly to rows, inflating error.
(B) It utilizes fractional degrees of freedom, confusing standard ANOVA tabulations.
(C) It fails to remove field heterogeneity, leading to inflated error.
(D) It strictly limits the number of treatments to exactly 4, reducing general applicability.

2011

135. In a Randomized Block Design (RBD), the statistical principle of local control is mathematically implemented by:
(A) Completely randomizing all treatments regardless of field position.
(B) Restricting randomization strictly across two perpendicular gradients.
(C) Splitting the plots into smaller sub-plots to accommodate factorial treatments.
(D) Grouping units into blocks and applying all treatments in each.

2012

136. Identify the mathematically INCORRECT statement regarding the physical layout of blocks in an RBD.
(A) Align blocks parallel to the fertility gradient for max internal variability.
(B) Blocks should ideally be formed perpendicular to the known fertility gradient of the field.
(C) Every treatment must strictly appear an equal number of times (usually once) within each complete block.
(D) The primary goal is to maximize the variance between blocks while strictly minimizing the variance within each block.

2017

137. An agronomist conducts an experiment using an RBD with 5 treatments and 4 blocks. What is the correct conceptual application for determining the degrees of freedom for the experimental error?
(A) $rt-1=20-1=19$
(B) $(r-1)(t-1)=3\times 4=12$
(C) $r+t-2=4+5-2=7$
(D) $t(r-1)=5\times 3=15$

NODIA

2012

138. The mathematical calculation of the Relative Efficiency (RE) of an RBD over a CRD essentially relies on estimating:
(A) The probability of a Type I error strictly occurring in the block effects.
(B) Theoretical CRD error variance compared to the actual RBD error.
(C) The ratio of the correlation coefficients of the two distinct designs.
(D) The exact physical size difference between the plots in the two designs.

2024

139. If one single observation is missing in an RBD involving t treatments and r blocks, the standard formula to estimate the missing value (Y) mathematically minimizes the error sum of squares and is given by:
(A) $Y=\dfrac{rB+tT-G}{(r-1)(t-1)}$
(B) $Y=\dfrac{rB+tT+G}{rt-1}$
(C) $Y=\dfrac{B+T-G}{r-t}$
(D) $Y=\dfrac{rB-tT}{G}$

in statistical analysis for modeling natural biological and agricultural phenomena.

47. (B) Mean = 0, Variance = 1
The standard normal distribution is a specific version of the normal distribution where the mean is transformed to zero and the variance is set to one. By converting raw data into Z-scores, researchers can compare observations from different normal distributions on a common scale. This transformation is essential for using standard normal probability tables to find areas under the curve for various values.

48. (D) They are located at one standard deviation from the mean, i.e., $x = \mu \pm \sigma$.
On a normal probability curve, the points of inflection are the specific locations where the curvature changes from concave to convex. These two points are mathematically located at exactly one standard deviation distance on either side of the mean. Identifying these points is useful for understanding the dispersion of the distribution and the rate at which the probability density decreases away from the center.

49. (A) The curve approaches the x-axis but never touches it, extending from $-\infty$ to $+\infty$.
The asymptotic nature of the normal curve refers to the fact that its tails extend infinitely in both directions from the mean. While the height of the curve decreases rapidly as the distance from the center increases, it never truly reaches zero. This implies that all values along the horizontal axis have a theoretical, though perhaps infinitesimal, probability of occurring in a normal population.

50. (B) Both A and R are true but R is not the correct explanation of A.
It is a fundamental fact that the standard normal distribution is perfectly symmetrical about its mean of zero. Additionally, the normal distribution is frequently used as a practical approximation for the Binomial distribution when the number of trials is large. While both statements are statistically accurate, the use of normal approximation does not provide the underlying mathematical reason for the curve's inherent symmetry.

51. (A) A list or map of all distinct sampling units in the target population.
A sampling frame is a comprehensive list, map, or directory that contains every individual sampling unit within the target population. It serves as the physical basis for selecting a sample through randomization. A complete and accurate sampling frame is essential to ensure that every member of the population has a known, non-zero chance of being included in the study, preventing selection bias.

52. (D) A parameter is a fixed constant, while a statistic is a variable calculated from a sample.
A parameter is a fixed, numerical characteristic of an entire population, such as the true population mean or variance, which is often unknown. In contrast, a statistic is a value calculated from a specific sample drawn from that population. While parameters are constant, statistics are random variables that vary from one sample to another, depending on which individual units are selected.

53. (B) 2.0
The standard error of the sample mean is calculated by dividing the population standard deviation by the square root of the sample size. For an agricultural population with a standard deviation of twelve and a sample size of thirty-six, the square root of thirty-six is six. Dividing twelve by six results in a standard error of exactly two point zero for the sample mean.

54. (C) The sampling distribution of the mean is perfectly uniform regardless of the sample size.
A sampling distribution represents the probability distribution of all possible values of a statistic for a given sample size. According to the Central Limit Theorem, the sampling distribution of the mean will approach a normal distribution as the sample size increases, regardless of the original population's shape. Therefore, claiming that the sampling distribution of the mean remains perfectly uniform is statistically incorrect.

55. (D) P-2, Q-1, R-3, S-4
Standard error formulas vary depending on the statistic being estimated. The standard error of the sample mean uses the population standard deviation divided by the square root of sample size. For proportions, it involves the square root of the product of p and q over n. Differences between means and proportions utilize pooled versions of these formulas that account for the variances of both samples.

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identically small physical field plots.
(B) The researcher needs to perfectly balance a two-directional fertility gradient.
(C) The entire experiment must be executed in a highly controlled, strictly homogeneous laboratory setting.
(D) One factor requires larger plots while another requires smaller sub-plots.

2001

149. A distinguishing factual characteristic of the ANOVA table for a Split-plot design is the strict presence of:
(A) Exactly zero degrees of freedom for the interaction effect between the factors.
(B) Two independent experimental error terms (Error A and Error B).
(C) A strictly singular, pooled error variance used to test all main and sub-plot effects equally.
(D) Four independent block effects corresponding to the cardinal directions.

2023

150. Based on the conceptual application of degrees of freedom and error variance partitioning in a standard Split-plot design, which of the following statements strictly holds true?
(A) The main-plot treatments are evaluated with strictly higher mathematical precision than the sub-plot treatments.
(B) The main-plot error variance is strictly equal to the sub-plot error variance.
(C) Sub-plot treatments have higher precision as Error B is usually smaller.
(D) The interaction effects are entirely confounded with the block effects.

2016

151. Match the specific ANOVA components in List I with their strictly corresponding degrees of freedom formulas in List II for a standard Split-plot design (where r = blocks, a = main-plot treatments, b = sub-plot treatments).
List I: (Structural Components)
P. Main-plot error (Error A)
Q. Sub-plot error (Error B)
R. Main-plot treatments
S. Sub-plot treatments
List II: (Degrees of Freedom Formula)
1. $b-1$
2. $(r-1)(a-1)$
3. $a(r-1)(b-1)$
4. $a-1$
(A) P-3, Q-2, R-1, S-4
(B) P-2, Q-3, R-4, S-1
(C) P-4, Q-1, R-2, S-3
(D) P-1, Q-4, R-3, S-2

2001

152. What is the strictly dictated cause-and-effect relationship governing the randomization procedure in a Split-plot design?
(A) Main-plots are randomized in blocks; then sub-plots are randomized within.
(B) Sub-plot treatments are entirely randomized across the entire field first, causing main-plots to be structurally irrelevant.
(C) Randomization is strictly mathematically restricted to an alternating checkerboard pattern to prevent border effects.
(D) All treatment combinations ($a \times b$) are randomized entirely simultaneously, identical to a factorial RBD.

2013

153. Identify the strictly INCORRECT statement regarding the statistical precision of a Split-plot design compared to a standard Factorial Randomized Block Design (FRBD).
(A) The sub-plot factor and the interaction strictly share the exact same error term (Error B) for significance testing.
(B) Split-plot design estimates the interaction effect with lower precision.
(C) A Split-plot design is often strictly dictated by physical or mechanical constraints of the agricultural treatments rather than pure statistical efficiency.
(D) In a Split-plot design, the main effects of the factor assigned to the main-plots are tested with strictly less precision than in a standard FRBD.

NODIA

2025

154. Probit analysis is fundamentally formally defined as a specialized statistical method primarily applied to analyze:
(A) The strict mathematical limits of continuous fertilizer yield curves in CRD.
(B) Binomial dose-response data, such as pesticide toxicity studies.
(C) The orthogonal partitioning of degrees of freedom in highly complex Latin squares.
(D) The strictly qualitative taxonomic classification of distinct insect species.

28. (D) Sum of squared deviations is minimum when taken from the arithmetic mean.
The arithmetic mean possesses a unique mathematical property where the sum of the squared deviations of all observations from it is smaller than the sum of squared deviations from any other value. This principle is fundamental to the method of least squares and serves as a cornerstone for defining variance as the most reliable absolute measure of dispersion in statistical analysis.

29. (C) V1, because its CV is lower than that of V2.
To determine which variety is more consistent, researchers compare their coefficients of variation rather than their absolute standard deviations. For variety one, the coefficient of variation is twelve point five percent, while for variety two, it is sixteen percent. Since a lower coefficient of variation indicates higher consistency and lower relative variability, variety one is considered the more stable option.

30. (A) Both A and R are true and R is the correct explanation of A.
Standard deviation is generally preferred over mean deviation for statistical inference because it is more amenable to algebraic manipulation. By squaring the deviations, standard deviation avoids the mathematical complications of absolute values used in mean deviation. This allows for advanced techniques like the partitioning of variance in ANOVA, which is essential for identifying different sources of experimental variation.

31. (B) They cannot occur simultaneously in a single trial of a random experiment.
In probability theory, two events are defined as mutually exclusive if they cannot happen at the same time in a single trial. If one event occurs, the other is strictly prohibited from occurring during that specific instance. Mathematically, the probability of the intersection of two mutually exclusive events is zero, which simplifies the calculation of their combined union probability.

32. (D) $\frac{P(A \cap B)}{P(B)}$
Conditional probability measures the likelihood of an event occurring given that another event has already happened. The formula for the probability of event A given event B is calculated by dividing the joint probability of both events occurring by the marginal probability of the conditioning event. This relationship is a fundamental component of Bayes' theorem and more complex probabilistic modeling in research.

33. (A) 0.72
When two events are statistically independent, the probability of both occurring simultaneously is the product of their individual probabilities. In this case, the probability that both seeds germinate is found by multiplying zero point eight by zero point nine. This results in a combined probability of zero point seven two, reflecting the joint likelihood of these two independent biological processes.

34. (C) The probability of any event can range from -1 to 1 inclusive.
One of the foundational axioms of probability theory is that the probability of any event must be a non-negative real number between zero and one, inclusive. A probability of zero indicates an impossible event, while a probability of one signifies a certain event. Therefore, the suggestion that probability can take a negative value like negative one is mathematically incorrect and invalid.

35. (C) P-3, Q-1, R-4, S-2
Independent events are those where the outcome of one does not influence the other. Exhaustive events cover the entire sample space when combined. Mutually exclusive events cannot occur together, meaning their intersection is empty. Complementary events are a specific pair of mutually exclusive and exhaustive events, where the probability of one occurring is exactly one minus the probability of the other.

36. (A) When events A and B are mutually exclusive.
The general additive law of probability states that the probability of the union of two events equals the sum of their individual probabilities minus the probability of their intersection. However, when two events are mutually exclusive, their intersection is impossible, and its probability is zero. In this specific case, the law simplifies to the direct sum of the individual probabilities.

37. (D) 4
A unique and defining mathematical characteristic of the Poisson distribution is that its mean and its variance are exactly equal. This single parameter, often denoted by lambda,

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ANSWERS

1. (A) A variable capable of assuming any numerical value within a given interval.
Continuous statistical variables are characterized by their ability to assume an infinite number of values within any specified range or interval. This contrasts with discrete variables, which only take on distinct, countable values. In agricultural research, measurements such as plant height, biomass, or soil moisture content serve as prime examples of continuous data because they allow for infinite fractional precision.

2. (C) Discrete variable
The number of tillers per wheat plant is a discrete variable because it results from a counting process. Discrete variables can only assume whole number values and cannot exist in fractional form between those integers. Since a plant can have two or three tillers but never two and a half, this data type represents distinct categories within statistical sampling methods.

3. (A) $k = 1 + 3.322 \log N$
Sturges' rule provides a standardized mathematical guideline for determining the optimal number of class intervals when constructing a frequency distribution from raw data. The formula relates the number of classes to the total observation count using a base-ten logarithm. It ensures that the distribution effectively summarizes the data while maintaining a balance between excessive detail and over-generalization in statistical analysis.

4. (D) Presence of unequal class intervals.
Frequency density is a critical adjustment used in histograms when class intervals are not of equal width. By dividing the frequency of a class by its corresponding interval width, researchers ensure that the area of each rectangle represents the actual frequency. This prevents visual distortion and maintains statistical accuracy when comparing data across categories with varying numerical ranges or spans in research.

5. (B) The upper limit of a class is excluded and placed in the next class.
The exclusive method of classification is a standard convention in grouped frequency distributions where the upper limit of one class serves as the lower limit of the subsequent class. In this approach, observations exactly matching the upper limit are excluded from the current interval and recorded in the next. This ensures mutual exclusivity and prevents overlapping counts in continuous data sets.

6. (C) Increased data summarization at the expense of losing individual identities.
Condensing raw observations into a frequency distribution facilitates data summarization and highlights the general shape and central tendency of the dataset. However, this process involves a significant trade-off because individual values lose their specific identities once they are grouped into class intervals. While the overall data becomes more manageable and easier to interpret, the precision of individual measurements is sacrificed.

7. (D) Mode
A histogram provides a visual representation of data frequency across intervals, where the highest bar indicates the most frequent class. In statistical analysis, the mode is the specific value with the highest frequency and can be graphically estimated by identifying the peak of the histogram. This makes the histogram a specialized tool for locating the modal value in continuous frequency distributions.

8. (A) A less than ogive is plotted against the lower class boundaries.
Ogive curves represent cumulative frequency distributions graphically. A less than ogive is constructed by plotting cumulative frequencies against the upper class boundaries of each interval, not the lower limits. These curves are essential for estimating positional measures such as the median, quartiles, and percentiles. The intersection of the two types of ogives precisely identifies the median value of the data.

9. (B) Class midpoints
A frequency polygon is created by plotting class frequencies against the respective midpoints of the intervals and then connecting these points with straight lines. To ensure the area under the

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2015

140. What is the strictly dictated statistical cause-and-effect impact of estimating one missing plot value using the formula in an RBD ANOVA?
(A) The treatment degrees of freedom are strictly increased by 1.
(B) The total degrees of freedom remain strictly mathematically unaffected.
(C) Degrees of freedom for error must strictly be reduced by 1.
(D) The block sum of squares strictly becomes identically zero.

2006

141. Which of the following pairs correctly identifies the strict mathematical randomization restriction applied in the stated design?
(A) Randomized Block Design (RBD) : One-way restriction (treatments randomized within blocks)
(B) Completely Randomized Design (CRD) : Two-way restriction (treatments randomized within rows and columns)
(C) Latin Square Design (LSD) : No restriction (completely random allocation)
(D) Split-Plot Design : Three-way restriction (rows, columns, and depth)

2002

142. A fundamental factual constraint governing the layout of a Latin Square Design (LSD) is that:
(A) The number of rows must strictly exceed the number of columns by exactly one.
(B) The total number of replications strictly equals the square root of the number of treatments.
(C) Number of treatments must equal number of rows and columns.
(D) Randomization must strictly happen within independent non-adjacent blocks only.

2017

143. In statistical terms, the Latin Square Design (LSD) is strictly defined as introducing a:
(A) One-way restriction on randomization to handle a single unidirectional gradient.
(B) Two-way restriction on randomization to handle perpendicular variations.
(C) Three-way restriction encompassing rows, columns, and altitudinal layers.
(D) Zero restriction, acting mathematically identical to a CRD.

2017

144. In a 5×5 Latin Square Design experiment, what is the correct mathematical application for calculating the degrees of freedom for the experimental error?
(A) $(t-1)(t-1) = 16$
(B) $t^2 - 1 = 24$
(C) $t(t-1) = 20$
(D) $(t-1)(t-2) = 12$

NODIA

2008

145. Identify the mathematically INCORRECT statement regarding the practical field applicability of the Latin Square Design (LSD).
(A) It is highly efficient for experiments with very large treatment counts.
(B) Each specific treatment must strictly appear exactly once in each row and exactly once in each column.
(C) The analysis partitions total variance strictly into rows, columns, treatments, and error.
(D) Due to strict layout constraints, LSD is typically restricted to experiments with 5 to 12 treatments.

2015

146. When comparing the mathematical efficiency of experimental designs under severe two-directional field heterogeneity, which strict hierarchy is generally inferred?
(A) CRD is strictly more efficient than both RBD and LSD.
(B) RBD is strictly more efficient than LSD, regardless of gradient orientation.
(C) LSD is more efficient as it removes variance from two distinct sources.
(D) LSD is completely mathematically equivalent to CRD in all field orientations.

2009

147. If a single plot value is destroyed in a strictly balanced Latin Square Design with m treatments, the correct statistical inference dictates that the missing value estimator formula mathematically utilizes:
(A) Totals of the affected row, column, treatment, and the grand total.
(B) The totals of strictly the affected treatment and affected block only, ignoring rows.
(C) Strictly the geometric mean of the two immediately adjacent neighboring plots.
(D) An absolute reduction of 2 degrees of freedom from the total count.

2014

148. The Split-plot design is formally defined as being strictly most appropriate when:
(A) All involved experimental factors require

mean that reflects both the subtraction and the division applied.

19. (A) $Mean - Mode = 3(Mean - Median)$
In moderately skewed distributions, Karl Pearson established an empirical relationship between the three main measures of central tendency. The difference between the mean and the mode is approximately equal to three times the difference between the mean and the median. This formula allows researchers to estimate one measure when the other two are known, especially when dealing with asymmetrical crop yield data.

20. (D) II
The median is a positional average that strictly divides a ranked dataset into two equal halves. Unlike the arithmetic mean, the median is not influenced by extreme outliers because its value depends solely on the middle position within the ordered series. It does not utilize every individual observation's magnitude in its calculation, which makes it particularly robust for analyzing skewed biological distributions.

21. (B) The frequencies are uniformly distributed over the interval of the median class.
When calculating the median for grouped data, the interpolation formula operates on the assumption that frequencies are distributed uniformly throughout the median class interval. This linear interpolation allows for the estimation of the specific point that divides the total frequency into two equal parts. Without this assumption of uniform distribution, the exact location of the median within the class would be indeterminate.

22. (C) Open-end classes or extreme outliers are present in the distribution.
Positional averages like the median and mode are often preferred in biological studies when datasets contain open-end classes or significant outliers. Since these measures depend on position or frequency rather than the magnitude of every observation, they remain stable even when extreme values are present. This provides a more representative center for distributions that do not follow a perfect normal curve.

23. (D) The mode is always mid-point of the modal class in grouped data.
The mode represents the most frequently occurring value in a dataset and can be identified as the peak of a frequency distribution. In grouped data, the mode is located within the modal class, but it is rarely exactly at the midpoint. Instead, its precise location is estimated through interpolation based on the frequencies of the classes immediately preceding and following the modal class.

24. (A) They cannot be combined using a simple weighted formula for two groups.
Positional averages are generally considered less suitable for advanced algebraic treatment because they lack the additive properties of mathematical averages. Specifically, the median or mode of a combined group cannot be calculated using a simple weighted formula from the medians or modes of the component sub-groups. This limitation makes them less flexible for complex statistical modeling compared to the arithmetic mean.

25. (C) I and III
Standard deviation is independent of the change of origin but depends on the scale of measurement. Meanwhile, the coefficient of variation serves as a relative measure of dispersion, typically expressed as a percentage to facilitate comparisons between different datasets. Variance is actually the square of the standard deviation, and mean deviation can be calculated from the mean, median, or even the mode.

26. (A) $\frac{\text{Standard Deviation}}{\text{Mean}} \times 100$
The coefficient of variation is a dimensionless relative measure of dispersion that expresses the standard deviation as a percentage of the arithmetic mean. This metric is particularly useful in agricultural experiments for comparing the consistency or variability of yields between different crops or varieties that may have vastly different average values, providing a standardized basis for evaluating relative stability.

27. (C) The variance of the yields will remain exactly the same.
A key property of variance is its independence from changes in the origin. When a constant value is added to or subtracted from every observation in a dataset, the spread of the data relative to the mean remains unchanged. Consequently, the variance and standard deviation of the resulting yields will be exactly the same as they were before the constant addition.

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polygon remains equivalent to the area under a histogram, the curve is typically extended to touch the horizontal axis at the midpoints of empty classes at both ends of the distribution.

10. (D) A is false but R is true.
Histograms and bar charts are fundamentally different despite their visual similarities. Histograms represent continuous frequency distributions where the area is proportional to frequency, whereas bar charts represent discrete or categorical data using bar heights. Because histograms account for class widths in a two-dimensional format, they are not interchangeable with bar charts, which typically use equal widths for categorical comparisons.

11. (A) The property that cumulative frequency curves mathematically intersect at the median, not the mean.
In any frequency distribution, the less than and more than cumulative frequency curves are mathematically designed to intersect at a specific point on the horizontal axis. This intersection point corresponds exactly to the median, which is the value that divides the ranked data into two equal halves. Consequently, these curves do not intersect at the arithmetic mean unless the distribution is perfectly symmetrical.

12. (C) It equals the total area of the corresponding histogram.
The total area under a frequency polygon is mathematically equivalent to the total area of the corresponding histogram for the same continuous distribution. This equality is maintained because the polygon effectively redistributes the area of the histogram rectangles without changing the overall total. This property ensures that the polygon provides a valid and comparable representation of the total frequency in grouped data.

13. (D) $AM > GM > HM$
For any set of distinct positive observations, the arithmetic mean is always greater than the geometric mean, which in turn is greater than the harmonic mean. This strict mathematical inequality exists because the different averaging methods prioritize values differently. These three measures of central tendency only become equal to one another when all observations in the dataset are identical in value.

14. (C) Harmonic Mean
The harmonic mean is the most appropriate measure for averaging rates or ratios when the numerator remains constant while the denominator varies. In this specific scenario, since the total amount of fertilizer applied is equal across all fields but the field sizes differ, the harmonic mean provides a more accurate representation of the average application rate than the standard arithmetic mean.

15. (B) P-3, Q-1, R-4, S-2
Different measures of central tendency possess unique mathematical properties. The median minimizes the sum of absolute deviations, while the arithmetic mean minimizes the sum of squared deviations. The harmonic mean is generally not determined through graphical methods. Conversely, the geometric mean is the standard statistical choice for calculating average growth rates, percentages, or ratios in biological and agricultural research datasets.

16. (D) Algebraic sum of deviations - Always equals zero
A fundamental algebraic property of the arithmetic mean is that the sum of the deviations of all observations from the mean is always zero. This occurs because the mean acts as the center of gravity for the data, balancing the positive and negative differences. This property distinguishes the arithmetic mean and serves as the basis for calculating variance and other higher-order statistical moments.

17. (A) 7.1
The combined mean of two datasets is calculated by taking the weighted average of their individual means. For these soil plots, the total sum of pH values is found by multiplying each sample size by its respective mean and adding them together. Dividing this total sum by the total number of plots results in a combined average pH value of exactly seven point one.

18. (C) The new mean is equal to the original mean minus 5, all divided by 2.
The arithmetic mean is sensitive to changes in both origin and scale. When a constant is subtracted from every observation, the mean decreases by that same constant. Similarly, when every observation is divided by a value, the mean is also divided by that value. Therefore, performing both operations results in a new

NODIA

represents the average number of occurrences of an event in a fixed interval of time or space. Therefore, if the mean of a Poisson distribution is four, the variance must also be four.

38. (B) Binomial distribution : n, p
Theoretical probability distributions are defined by specific parameters. The Binomial distribution is characterized by two parameters: the number of independent trials and the constant probability of success in each trial. In contrast, the Poisson distribution relies only on a single mean parameter, while the normal distribution is defined by its mean and variance to describe the population's center and spread.

39. (C) When $n\,to\,\infty$ and $p\,to\,0$ such that np is finite.
The Poisson distribution serves as a mathematical limit for the Binomial distribution when the number of trials becomes very large and the probability of success becomes very small. This transformation occurs under the condition that the product of these two values remains a finite constant. This makes the Poisson distribution ideal for modeling rare events occurring in large populations or samples.

40. (A) I, II, III and V
The Binomial distribution is a discrete probability distribution that models a fixed number of independent trials, each with a dichotomous outcome of success or failure. A key mathematical property is that the mean is always strictly greater than the variance. Crucially, the probability of success must remain constant across all trials, which distinguishes it from other types of sampling distributions.

41. (B) Poisson distribution
In agricultural entomology, the Poisson distribution is the most appropriate model for counting rare events or organisms in a large area. This is because the distribution specifically describes the number of occurrences within a fixed unit of space when the average rate is low. Counting rare mutant insects per square meter follows this pattern, as the individual probability of occurrence is small.

42. (B) The PMF of a Poisson distribution strictly requires knowing the total population size N.
The probability mass function for a discrete distribution provides the probability for specific individual values. While the sum of these probabilities must always equal one, the requirements for each distribution vary. The Poisson distribution uniquely requires only its mean parameter and does not depend on knowing the total population size, unlike the Binomial distribution which requires knowing the specific number of trials.

43. (A) Symmetrical when $p = 0.5$, positive skew when $p < 0.5$, and negative skew when $p > 0.5$.
The shape and skewness of a Binomial distribution are primarily determined by the probability of success. When this probability is exactly zero point five, the distribution is perfectly symmetrical. If the probability is less than zero point five, the distribution exhibits positive skewness. Conversely, when the probability exceeds zero point five, the distribution becomes negatively skewed, with a longer tail on the left.

44. (C) $f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$
The probability density function of a normal distribution is a mathematical expression that describes its characteristic bell-shaped curve. It incorporates two parameters: the population mean, which locates the center of the distribution, and the standard deviation, which determines its width or spread. The formula ensures that the total area under the curve is exactly one, following the standard rules of probability.

45. (D) I, II, III, IV
In a normal distribution, specific intervals around the mean encompass predictable proportions of the total area. One standard deviation covers approximately sixty-eight percent, while one point nine six standard deviations cover ninety-five percent. Two standard deviations cover about ninety-five point four percent, and three standard deviations encompass ninety-nine point seven percent. Consequently, these intervals increase in area in that specific order.

46. (C) It is bell-shaped and its mean, median, and mode coincide at the center.
The normal curve is a perfectly symmetrical, bell-shaped distribution where the arithmetic mean, median, and mode all coincide at the exact center. It is asymptotic to the horizontal axis, meaning it approaches but never actually touches it at either end. These properties make it the most widely used theoretical distribution

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2015

155. A strictly factual foundation of probit analysis is that it mathematically transforms the classic asymmetrical sigmoid dose-mortality curve into:

(A) A linear regression line by applying specialized transformations.

(B) A perfect parabolic curve utilizing quadratic equations.

(C) A strictly bounded circular plot showing periodic resistance.

(D) A strictly horizontal line where variance is completely eliminated.

2013

156. In the conceptual mathematical application of probits, the probit value corresponding to a specific mortality proportion is calculated strictly by taking the Normal Equivalent Deviate (NED) and:

(A) Mathematically squaring it to strictly eliminate negative variances.

(B) Strictly multiplying it by 10 to shift the decimal.

(C) Adding 5 to avoid handling negative mathematical values.

(D) Taking its natural logarithm to strict base e

2006

157. An agricultural toxicologist strictly applies probit analysis to define the $LD_{\{50\}}$. What does this metric strictly represent?

(A) The maximum allowable lethal dose before strictly 50% of the crop itself is fundamentally damaged.

(B) The precise lethal duration strictly required for 50 insects to strictly die in a single closed chamber.

(C) The mathematically combined probability that an insect will strictly survive 50 consecutive pesticide applications.

(D) The median lethal dose causing death in 50% of the population.

2016

158. In the standard execution of a probit regression analysis, which strictly correct mathematical statement explains the transformation of the independent variable (dosage)?

(A) Dosages strictly remain completely untransformed to strictly preserve field application rates.

(B) Dosages are strictly converted to probits, while mortality is strictly logged.

(C) Dosages are transformed to log-dose to normalize tolerance distributions.

(D) Dosages are transformed into angles using the arcsine method.

2024

159. What valid historical and mathematical inference connects D.J. Finney directly to modern probit analysis?

(A) He strictly established the first fundamental proof of the Central Limit Theorem.

(B) He formalized the statistical procedures for biological probit analysis.

(C) He strictly invented the Split-plot design for pesticide field trials.

(D) He strictly proved that log transformations are mathematically invalid for any toxicological mortality data.

2015

160. In the fitted linear probit regression equation $Y = a + bX$ (where Y is the strictly computed probit mortality and X is the strictly log-dose), which of the following is the most appropriate strictly best interpretation of the slope parameter (b)?

(A) It strictly represents the exact calculated $LD_{\{50\}}$ point on the x-axis.

(B) It strictly indicates the exact baseline mortality rate when absolute zero dose is applied.

(C) It strictly measures the exact maximum percentage mortality the applied chemical can fundamentally achieve at infinite dose.

(D) It reflects the variance of the underlying tolerance distribution.

****

NODIA

56. (A) It reduces the standard error, thereby increasing the precision of the estimate.
Increasing the sample size in an experiment has the direct statistical effect of reducing the standard error of the estimates. This occurs because the denominator in the standard error formula becomes larger, resulting in a smaller overall value. A smaller standard error signifies that the sample statistic is a more precise and reliable estimate of the true population parameter being studied.

57. (B) Sampling error decreases with sample size, while non-sampling error may increase.
Sampling error arises from the inherent variability of using a subset rather than the whole population and generally decreases as sample size increases. Non-sampling errors, however, stem from human mistakes, measurement bias, or faulty data collection procedures. In large-scale surveys, increasing the sample size may inadvertently increase non-sampling errors due to the increased complexity and scale of the data collection process.

58. (B) Cluster Sampling
Cluster sampling is a technique where the population is divided into groups or clusters, often based on geographical boundaries. Instead of selecting individual units, the researcher randomly selects entire clusters and surveys every member within them. This method is particularly useful in agricultural surveys when a full list of individual farmers is unavailable but a list of villages or districts is accessible.

59. (A) ${}^{N}C_{n}$
In simple random sampling without replacement from a finite population, once a unit is selected, it cannot be chosen again for the same sample. The total number of unique possible samples of size n that can be drawn from a population of size N is mathematically determined using the combinations formula, often denoted as N choose n. This ensures equal selection probability.

60. (A) I and III
Systematic sampling involves selecting a random starting point and then choosing every kth element from a list. While it is easy to implement, it can introduce significant bias if the sampling frame contains a periodic or cyclical trend that coincides with the sampling interval. This method is generally efficient but lacks the automatic error-reduction properties found in stratified random sampling designs.

61. (D) Optimum allocation - Minimizes variance for a given cost or minimizes cost for variance.
Optimum allocation in stratified sampling is designed to provide the most precise estimates for a given total cost or to minimize costs for a desired level of precision. It achieves this by allocating larger sample sizes to strata that are larger in size, have higher internal variability, or have lower costs of sampling. This approach maximizes the overall efficiency of the statistical design.

62. (C) When a complete sampling frame of individual units is unavailable or too costly to compile.
Although cluster sampling is often less statistically efficient than simple random sampling due to high similarity within clusters, it is frequently preferred for practical reasons. It is used when compiling a complete sampling frame of individual units is either impossible or prohibitively expensive. In such cases, sampling villages or clusters provides a more feasible and cost-effective method for conducting agricultural field research.

63. (B) It partitions variance so between-stratum variation does not affect the sampling error.
Stratified random sampling is generally more efficient than simple random sampling because it partitions the total population variance into distinct strata. By ensuring that each stratum is represented in the sample, this technique effectively eliminates the variation between strata from the sampling error. Consequently, the resulting sample mean is a more precise estimate of the true population mean for heterogeneous populations.

64. (D) When sampling trees in an orchard planted at regular, known spacing intervals.
Systematic sampling is highly effective when applied to populations that are already arranged in a regular, orderly fashion. For example, in an orchard where trees are planted at fixed, known intervals, selecting every tenth tree provides a representative sample that is easy to execute in the field. This method ensures uniform coverage of the area while maintaining simplicity in the selection process.

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65. (C) I and III
In hypothesis testing, researchers face two primary types of errors. A Type I error occurs when a true null hypothesis is incorrectly rejected, with its probability denoted by alpha. A Type II error occurs when a false null hypothesis is not rejected, with its probability denoted by beta. Both errors represent fundamental risks that must be balanced when designing and interpreting statistical tests.

66. (C) The probability of observing a statistic as extreme as computed, given H_0 is true.
The p-value is the calculated probability of obtaining a test statistic at least as extreme as the one actually observed, assuming that the null hypothesis is true. It serves as a measure of the strength of evidence against the null hypothesis. A very small p-value indicates that the observed data is unlikely to have occurred by random chance alone under the null hypothesis.

67. (A) The maximum allowable probability of committing a Type I error.
The level of significance, denoted by alpha, represents the maximum probability that a researcher is willing to risk committing a Type I error. It is a predetermined threshold used to decide whether to reject the null hypothesis. Common levels include five percent or one percent, signifying a conservative approach to claiming that an observed effect is statistically significant and not due to chance.

68. (D) It is defined as $1-\beta$, the probability of correctly rejecting a false null hypothesis.
The power of a statistical test is defined as the probability of correctly rejecting a null hypothesis when it is actually false. Mathematically, it is calculated as one minus the probability of a Type II error. A high power indicates that the test is sensitive enough to detect a true difference or effect when one exists in the population being studied by the researcher.

69. (B) A simple hypothesis completely specifies all population parameters, whereas a composite does not.
A simple hypothesis is one that completely and uniquely specifies the population's probability distribution by defining all its parameters. In contrast, a composite hypothesis does not fully specify the distribution, often by stating that a parameter belongs to a certain range or is simply not equal to a specific value. This distinction is crucial for determining the appropriate mathematical procedures in hypothesis testing.

70. (C) A is true but R is false.
In a single sample t-test, the degrees of freedom are indeed calculated as the sample size minus one. This value represents the number of independent observations available to estimate the population variance. However, degrees of freedom are not equivalent to the probability of committing a Type I error; rather, they are used to determine the critical value and the shape of the t-distribution.

71. (D) The alternative hypothesis specifying a directional difference.
The choice between a one-tailed and a two-tailed test is strictly determined by the nature of the alternative hypothesis. A one-tailed test is used when the researcher specifies a directional effect, such as predicting that one treatment mean will be specifically higher or lower than another. If the direction is not specified, a two-tailed test must be used to detect differences in either direction.

72. (A) The sample size is large ($n > 30$) and the population variance is known.
A large sample Z-test is appropriately used when the sample size is greater than thirty and the population variance is known or can be reliably estimated from the large sample. These conditions allow for the application of the Central Limit Theorem, which ensures that the sampling distribution of the mean is approximately normal, facilitating the use of standard normal probability tables for hypothesis testing.

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73. (B) The population standard deviation must be mathematically known prior to testing.
Student's t-test is specifically designed for situations where the sample size is small and the population standard deviation is unknown. The test assumes that the parent population is normally distributed and that observations are independent. Crucially, the t-test uses the sample standard deviation as an estimate for the unknown population parameter, making it distinct from the large-sample Z-test procedure.

74. (B) Paired t-test
When an agronomist measures the same subjects or plots before and after a treatment,

the resulting observations are naturally paired and dependent. The paired t-test is the most appropriate parametric procedure to evaluate the mean difference between these two related sets of measurements. It increases statistical power by focusing on the change within each individual unit, thereby controlling for initial variability between the plots.

75. (A) P-2, Q-4, R-1, S-3
The degrees of freedom for different parametric tests depend on the sample structure. For a single sample t-test and a paired t-test, it is calculated as n minus one, based on the number of observations or pairs. An independent two-sample t-test uses the sum of both sample sizes minus two. Large sample Z-tests do not rely on degrees of freedom in the same way.

76. (C) It is the sum of observations in both samples minus two $(10 + 12 - 2 = 20)$.
In an independent two-sample t-test, the degrees of freedom are calculated by summing the sizes of both samples and then subtracting two. This adjustment accounts for the two independent means that must be estimated from the data before the pooled variance can be calculated. For samples of sizes ten and twelve, the resulting degrees of freedom for the test would be exactly twenty.

77. (D) Designated error levels may not match theoretical values, compromising validity.
If the assumption of normality is severely violated in a small-sample t-test, the actual probability of committing a Type I or Type II error may deviate significantly from the theoretical levels set by the researcher. This compromises the validity of the test's conclusions. In such cases, the resulting p-values may be misleading, and the researcher might need to consider alternative non-parametric statistical methods.

78. (C) The t-distribution is leptokurtic with heavier tails than the Z distribution.
While both the Z and t-distributions are symmetrical and bell-shaped, the t-distribution has a lower peak and thicker tails than the standard normal distribution. This leptokurtic property accounts for the additional uncertainty involved in estimating the population variance from a small sample. As the degrees of freedom increase, the t-distribution gradually approaches the shape of the standard normal Z-distribution until they are identical.

79. (B) Test if observed frequencies deviate from a theoretical probability distribution.
The chi-square test for goodness of fit is a statistical procedure used to determine whether the observed frequencies in a dataset significantly deviate from a specific theoretical probability distribution. It allows researchers to evaluate if their empirical findings are consistent with a hypothesized model, such as the Mendelian ratios in genetics or the Poisson distribution in insect population studies across various environments.

80. (A) III, IV and V
The chi-square distribution is a continuous probability distribution that is non-negative and generally positively skewed. Its mean is exactly equal to its degrees of freedom, and its variance is equal to twice the degrees of freedom. It is an essential tool for testing the independence of categorical attributes and for assessing the goodness of fit between observed data and hypothesized theoretical distributions.

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81. (A) $(r-1)(c-1)$
For a contingency table with r rows and c columns, the degrees of freedom for the chi-square test of independence are calculated as the product of row count minus one and column count minus one. This value represents the number of cell frequencies that can be independently assigned before the remaining cell values are determined by the fixed row and column totals in the data.

82. (C) When the expected frequency in any individual cell of the table falls below 5.
Yates' correction for continuity is a specific adjustment applied to the chi-square formula for two-by-two contingency tables. It is most appropriately used when the expected frequency in any individual cell is less than five. By subtracting zero point five from the absolute difference between observed and expected values, this correction prevents the overestimation of statistical significance when working with small samples.

83. (A) The sum of independent chi-square variates is also a chi-square variate.
A fundamental additive property of the chi-square distribution is that the sum of independent chi-square random variables is also a chi-square

predicting X from Y—are mathematically guaranteed to intersect at a specific coordinate. This point of intersection is defined by the arithmetic means of the two variables. This property reflects the fact that the regression lines are centered on the average values of the dataset they were derived from.

102. (C) 64% of yield variation is explained by its linear regression on rainfall.
The coefficient of determination, calculated as the square of the correlation coefficient, measures the proportion of the total variance in the dependent variable that is explained by its linear relationship with the independent variable. If the correlation between yield and rainfall is zero point eight zero, then sixty-four percent of the variation in yield can be attributed to changes in rainfall.

103. (D) Correlation measures interdependence, whereas regression determines dependence form.
Correlation and regression serve distinct analytical purposes. Correlation focuses on measuring the strength and direction of the linear interdependence between two variables without assuming a specific causal direction. Regression analysis, however, is used to determine the exact functional form of the dependence, allowing researchers to predict the value of a dependent variable based on the known values of one or more predictors.

104. (A) It must strictly be negative, mirroring the direction of the relationship.
There is a strict mathematical relationship between the sign of the correlation coefficient and the sign of the regression coefficients. If the correlation between two variables is negative, it indicates that they have an inverse relationship. Consequently, the slope of the regression line, which represents the regression coefficient, must also be negative to accurately reflect this downward trend in the data.

105. (C) I, III and IV
Multiple correlation measures the collective linear relationship between one dependent variable and a set of independent variables. Partial correlation, however, isolates the relationship between two specific variables while mathematically controlling for the influence of a third variable. Both concepts are essential for understanding complex systems where multiple factors interact and influence agricultural outcomes, allowing for more precise modeling of variable dependencies.

106. (B) $0 \leq R \leq 1$
Unlike the simple correlation coefficient, which can range from negative one to positive one, the multiple correlation coefficient is strictly non-negative. Its mathematical limits are defined between zero and one. A value of zero indicates no linear relationship between the predictors and the dependent variable, while a value of one indicates that the independent variables perfectly predict the dependent variable.

107. (A) Assess the pure relationship between two variables by holding others constant.
The calculation of a partial correlation coefficient allows researchers to assess the pure linear association between two variables by removing the overlapping influence of other confounding factors. In agricultural studies, this is used to understand the direct relationship between two traits, such as soil nitrogen and crop yield, by holding other variables like rainfall or temperature constant during the statistical analysis.

108. (C) $\beta = (X'X)^{-1}X'Y$
In multiple linear regression using matrix notation, the vector of least squares estimated coefficients is found by solving the normal equations. This involves multiplying the inverse of the product of the transposed design matrix and the design matrix itself by the product of the transposed design matrix and the dependent variable vector. This formula provides the unique set of parameters that minimizes error.

109. (D) Presence of perfect linear relationship (multicollinearity) among predictors.
A critical assumption of multiple linear regression is that the independent variables are not perfectly correlated with each other. The presence of perfect multicollinearity is a severe violation because it makes it mathematically impossible to unique determine the individual effects of each predictor. This situation leads to unstable coefficient estimates and large standard errors, rendering the fitted model unreliable for interpretation or prediction.

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reject the null hypothesis of equal variances. In the case of comparing two mango orchards, this finding leads to the conclusion that the orchards possess heterogeneous variances. This result is important because it may affect the choice of subsequent statistical tests, such as requiring an adjusted t-test for unequal variances.

93. (D) $-1 \leq r \leq 1$
Pearson's product-moment correlation coefficient is a standardized measure of the linear relationship between two variables. Its mathematical value is strictly bounded between negative one and positive one, inclusive. A value of positive one indicates a perfect positive linear relationship, while negative one indicates a perfect negative linear relationship. A value of zero signifies that no linear association exists between the variables.

94. (C) A significant correlation coefficient strictly proves a causal relationship exists.
Correlation measures the strength and direction of a linear relationship but does not inherently imply that one variable causes changes in the other. A high correlation coefficient only signifies that the variables move together in a predictable linear pattern. Therefore, concluding that a significant correlation strictly proves a causal relationship is a fundamental logical error in statistical interpretation and scientific reasoning.

95. (B) P-2, Q-1, R-3, S-4
Different correlation coefficient values correspond to distinct patterns in a scatter diagram. A value of positive one creates a perfect upward-sloping line, while negative one creates a perfect downward-sloping line. A value of zero results in a random dispersion of points with no clear trend. Fractional positive values, such as those between zero and one, appear as a discernible upward-trending band.

96. (D) When the data is ordinal, such as ranking the visual quality of crop phenotypes.
Spearman's rank correlation is a non-parametric measure used to evaluate the monotonic relationship between two variables. It is most appropriate when data is ordinal or when researchers are ranking qualitative traits, such as the visual quality of crop phenotypes or sensory evaluations. This method is also useful when the assumptions of normality required for Pearson's correlation are significantly violated in the dataset.

97. (A) It is unchanged as r is independent of change of origin and scale.
A key mathematical property of the correlation coefficient is that it is entirely independent of changes in both the origin and the scale of measurement. Multiplying one variable by a positive constant and adding a value to another does not alter the strength or direction of their linear relationship. Consequently, the calculated value of r remains exactly the same after these linear transformations.

98. (C) $t = \dfrac{r\sqrt{n-2}}{\sqrt{1-r^2}}$
To test whether a sample correlation coefficient is significantly different from zero, researchers use a t-statistic derived from the value of r and the sample size. The formula involves the square root of the quantity n minus two, representing the degrees of freedom for the test. This procedure allows for the determination of whether the observed linear relationship in the sample is significant.

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99. (A) Minimizes the sum of squared vertical deviations of points from the fitted line.
The method of least squares is the standard procedure for estimating the coefficients of a regression line. It works by finding the specific line that minimizes the sum of the squared vertical distances between the observed data points and the values predicted by the model. This approach ensures that the resulting line provides the best possible fit to the data under normal distribution assumptions.

100. (D) I and II
Regression coefficients possess several important mathematical properties. First, both coefficients must always have the same algebraic sign, which is also the sign of the correlation coefficient. Second, the geometric mean of the two regression coefficients is equal to the correlation coefficient. However, while they are independent of the change of origin, they are sensitive to the change of scale in variables.

101. (B) They intersect at the point defined by the arithmetic means $(\bar{x}, \bar{y})$.
In simple linear regression, the two independent lines—one predicting Y from X and the other

136. (A) Align blocks parallel to the fertility gradient for max internal variability.
For a Randomized Block Design to be effective, blocks should be laid out perpendicular to the known fertility gradient of the field. This ensures that the units within each block are as similar as possible. Therefore, the suggestion to align blocks parallel to the gradient is incorrect, as it would maximize internal variability within each block and fail to effectively reduce error.

137. (B) $(r-1)(t-1) = 3 \times 4 = 12$
The degrees of freedom for the experimental error in a Randomized Block Design are calculated as the product of the number of blocks minus one and the number of treatments minus one. For an experiment with five treatments and four blocks, this results in exactly twelve degrees of freedom for the error term. This value represents the variation remaining after accounting for effects.

138. (B) Theoretical CRD error variance compared to the actual RBD error.
The relative efficiency of a Randomized Block Design over a Completely Randomized Design is determined by comparing their respective error variances. It involves estimating what the error variance would have been if the experiment had been conducted as a CRD using the same experimental units. An efficiency value greater than one hundred percent indicates that blocking effectively reduced the error and improved precision.

139. (A) $Y = \dfrac{rB + tT - G}{(r-1)(t-1)}$
When a single observation is missing in a Randomized Block Design, it can be estimated using a specific formula that incorporates the total for the affected block, the total for the affected treatment, and the grand total of the remaining data. This estimation procedure is designed to minimize the error sum of squares, allowing the researcher to proceed with a standard ANOVA calculation.

140. (C) Degrees of freedom for error must strictly be reduced by 1.
After estimating a missing plot value in an RBD, the researcher must make a specific adjustment to the subsequent ANOVA. While the analysis is conducted on the full dataset including the estimated value, the degrees of freedom for the experimental error must be reduced by one. This correction accounts for the fact that one value was not actually observed but mathematically derived.

141. (A) Randomized Block Design (RBD) : One-way restriction (treatments randomized within blocks)
Experimental designs differ in the restrictions they place on the randomization process. A Randomized Block Design utilizes a one-way restriction where treatments are randomized independently within each block. In contrast, a Latin Square Design imposes a two-way restriction, ensuring that each treatment appears exactly once in every row and every column, while a Completely Randomized Design has no such physical restrictions.

142. (C) Number of treatments must equal number of rows and columns.
A fundamental factual constraint of the Latin Square Design is that the number of treatments must be exactly equal to the number of rows and the number of columns. This square arrangement is what allows the design to account for two perpendicular gradients in the field. This requirement also means that the total number of experimental units is always the square of the treatment count.

143. (B) Two-way restriction on randomization to handle perpendicular variations.
The Latin Square Design is strictly defined by its two-way restriction on randomization. By ensuring that every treatment appears exactly once in each row and exactly once in each column, the design effectively controls for variation in two perpendicular directions. This makes it significantly more efficient than designs that only account for a single gradient or those that utilize no blocking at all.

144. (D) $(t-1)(t-2) = 12$
In a Latin Square Design with t treatments, the degrees of freedom for the experimental error are calculated as the product of t minus one and t minus two. For a five-by-five Latin Square, this results in exactly twelve degrees of freedom. This formula reflects the fact that the total variation is partitioned between rows, columns, and treatments before error is estimated.

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110. (A) II, I, IV, III
Constructing a multiple linear regression model begins with identifying the dependent and independent variables. The next step is to estimate the regression parameters using the least squares method. Once the model is fitted, its overall significance is tested using an ANOVA F-test. Finally, diagnostic checks are performed to ensure that the underlying statistical assumptions, such as homoscedasticity, are satisfied.

111. (B) In a Random model, treatments are a sample from a larger population.
In the Analysis of Variance, the distinction between Fixed and Random effects models depends on how treatments are selected. In a Fixed effects model, the experimenter focuses specifically on a predetermined set of treatments. In a Random effects model, the treatments used in the experiment are considered a random sample drawn from a much larger population of possible treatments for broader generalization.

112. (D) The Total Sum of Squares into non-overlapping sources of variation.
The fundamental principle of ANOVA is the mathematical partitioning of the total sum of squares into distinct, non-overlapping components that represent different sources of variation. This allows researchers to separate the variation caused by treatments, environmental factors like blocks, and random experimental error. By comparing these components, the significance of each source of variation can be assessed through the F-test.

113. (A) Parent population variances must be heterogeneous for a significant F-ratio.
A key assumption for the valid application of ANOVA is the homogeneity of variances, meaning that the error variance should be constant across all treatment groups. Other essential assumptions include the normality of the parent populations, the independence of experimental errors, and the additivity of treatment and environmental effects. Therefore, claiming that variances must be heterogeneous is statistically incorrect and violates core principles.

114. (C) The Fixed model EMS contains fixed squared effects; the Random model EMS contains treatment population variance.
The Expected Mean Squares provide a theoretical basis for identifying the appropriate error term for F-tests in different ANOVA models. In a Fixed effects model, the EMS for treatments includes the fixed squared effects of those specific treatments. In a Random effects model, the EMS for treatments instead includes the variance component of the entire population from which those treatments were sampled.

115. (A) Apply an arcsine transformation to the data prior to the ANOVA.
Percentage or proportion data often follow a binomial distribution, which violates the ANOVA assumption of constant variance since the variance depends on the mean. When dealing with percentages between zero and one hundred, researchers typically apply an arcsine or angular transformation to the data before analysis. This stabilizes the variance and makes the data more suitable for the standard ANOVA procedure.

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116. (D) P-3, Q-1, R-4, S-2
Degrees of freedom in ANOVA reflect the experimental design's structure. For a standard experiment with t treatments and r replications, the total degrees of freedom is tr minus one. The treatment degrees of freedom is t minus one. In a CRD, the error degrees of freedom is t times the quantity r minus one, while in an RBD, block degrees of freedom is r minus one.

117. (B) Only after the overall ANOVA F-test for treatments has been found mathematically significant.
Multiple comparison procedures, such as the Least Significant Difference test, are designed to identify which specific treatment means differ from one another. However, these tests are factually permitted only after the overall ANOVA F-test has found a significant difference among the treatments. Performing these tests when the F-test is non-significant can lead to an inflated risk of committing Type I errors.

118. (C) The minimum difference needed between two means for significance.
The Least Significant Difference is a statistical threshold used in the comparison of treatment means following a significant ANOVA. It represents the minimum numerical difference

random variable. The degrees of freedom for the resulting sum is equal to the total sum of the individual degrees of freedom from each component. This property is crucial for combining results from multiple independent tests and for more complex theoretical derivations.

84. (D) There is no significant evidence to reject the null hypothesis of independence.
When the calculated chi-square value is much smaller than the critical value from the distribution table, it indicates that the differences between observed and expected frequencies are likely due to random chance. Therefore, there is no significant evidence to reject the null hypothesis. In a test of independence, this result would suggest that the two attributes being studied are likely independent.

85. (B) II, I, III, IV
Conducting a chi-square goodness of fit test follows a logical sequence. First, the researcher must define the null and alternative hypotheses. Next, the expected frequencies are computed based on the theoretical distribution being tested. Then, the chi-square test statistic is calculated using the observed and expected values. Finally, this calculated value is compared with the critical value to reach a final conclusion.

86. (C) The ratio of the two sample variances, with the larger variance in the numerator.
The F-statistic used to test the equality of two population variances is calculated by taking the ratio of the two sample variances. By convention, the larger variance is placed in the numerator to ensure that the resulting F-value is greater than or equal to one. This ratio follows an F-distribution, which is used to determine whether the observed difference in variability is significant.

87. (D) It strictly ranges from 0 to $+\infty$.
The F-distribution is a continuous probability distribution that is strictly non-negative, as it is derived from the ratio of two independent chi-square variables. Consequently, its mathematical range extends from zero to positive infinity. Because variances and their ratios cannot be negative, the entire probability mass of the F-distribution is located on the positive side of the horizontal axis, showing positive skew.

88. (A) The two samples can be mathematically dependent or paired.
The valid application of an F-test for comparing variances requires several strict assumptions. The samples must be drawn independently from each other, and each sample must consist of independent observations from a normally distributed population. Therefore, the suggestion that the two samples can be mathematically dependent or paired is an exception and would violate the fundamental requirements for the traditional variance ratio test.

89. (B) The ratio of the treatment mean square to the error mean square.
In the framework of Analysis of Variance, the F-test fundamentally evaluates whether the variation between treatment means is significantly greater than the variation within the treatments. This is achieved by calculating the ratio of the treatment mean square to the error mean square. A significantly large F-ratio suggests that the treatment effects are real and not merely the result of random experimental error.

90. (A) Both A and R are true and R is the correct explanation of A.
It is a established mathematical fact that the square of a t-distributed variable with n degrees of freedom is equivalent to an F-distributed variable with one and n degrees of freedom. This relationship exists because both distributions are fundamentally derived from combinations of standard normal and chi-square variables. This connection highlights the underlying unity within parametric statistical tests and their theoretical probability foundations.

91. (A) F-test
The F-test is formally known in classical statistics as the Variance Ratio Test because its primary function is to compare the relative magnitudes of two independent variance estimates. Whether used to test for the equality of two population variances or as part of an ANOVA procedure, the test consistently relies on the ratio of two mean squares to determine the significance of differences.

92. (C) Reject the null hypothesis and conclude the orchards have heterogeneous variances.
When the calculated F-value significantly exceeds the critical value, the researcher must

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127. (B) It reduces the standard error of the mean, increasing precision.
Increasing the number of replications in an agricultural experiment has a direct positive impact on statistical precision. By providing more independent observations for each treatment, replication reduces the standard error of the treatment means. This makes it easier to detect significant differences between treatments and increases the reliability of the experiment's findings by averaging out the effects of random environmental variation.

128. (C) P-3, Q-1, R-2
Each principle of experimental design serves a specific statistical purpose. Randomization is essential to ensure that the estimate of experimental error remains unbiased. Replication is necessary to provide the actual mathematical estimate of that error variance. Local control is primarily used to reduce the overall magnitude of the experimental error variance by accounting for known sources of environmental heterogeneity in the field.

129. (A) Homogeneous experimental units, such as laboratory environments.
The Completely Randomized Design is the simplest experimental design and is most suitable when the experimental units are highly homogeneous. Because it does not utilize blocking to control for environmental gradients, it is typically used in laboratory settings, greenhouses, or other controlled environments where external variation is minimal. In such conditions, CRD offers maximum flexibility and the highest possible degrees of freedom.

130. (D) I, III, IV, II
To layout a CRD, the researcher first determines the total number of experimental units required. Next, those homogeneous units are identified and demarcated in the field or lab. Then, a randomization process, such as using a random number table, is used to select units from the total pool. Finally, treatments are assigned to the selected units until each treatment's replication quota is reached.

131. (A) Treatments and Experimental Error
In the ANOVA for a Completely Randomized Design, the total variation in the data is partitioned into only two independent sources. These are the variation due to the treatments being studied and the variation due to random experimental error. This simple structure reflects the lack of any grouping or blocking of the experimental units, making the analysis straightforward but sensitive to environmental heterogeneity.

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132. (D) $N-t$
For a Completely Randomized Design with a total of N experimental units and t treatments, the degrees of freedom for the experimental error are calculated as N minus t. This value represents the total number of observations available for estimating the error variance after accounting for the degrees of freedom used by the treatment means and the grand mean of the experiment.

133. (B) ANOVA is calculated using unequal replications and adjusted N.
One of the practical advantages of the Completely Randomized Design is its flexibility in handling missing data. If an observation is lost or a plot is destroyed, the analysis can still be performed using the remaining data by treating it as an experiment with unequal replications. The ANOVA formulas are simply adjusted for the new totals and sample sizes without requiring complex estimation.

134. (C) It fails to remove field heterogeneity, leading to inflated error.
The primary statistical limitation of the Completely Randomized Design in field conditions is its inability to account for spatial heterogeneity, such as soil fertility gradients. Because it lacks local control through blocking, any existing environmental variation is pooled directly into the experimental error. This often leads to an inflated error mean square, which reduces the precision of the design and its power.

135. (D) Grouping units into blocks and applying all treatments in each.
In a Randomized Block Design, the principle of local control is implemented by grouping experimental units into blocks based on a known fertility or environmental gradient. Each treatment is then assigned once to a unit within every block. This arrangement ensures that the variation between blocks can be mathematically removed from the experimental error, thereby increasing the precision of the treatment comparisons.

required between two means for them to be considered statistically different at a specified level of significance. This value is calculated using the error mean square, the number of replications, and the critical t-value for error.

119. (D) LSD is less conservative and more prone to Type I errors than DMRT.
Fisher's Least Significant Difference test is often considered less conservative than Duncan's Multiple Range Test. While the LSD test uses a single critical value for all comparisons, DMRT adjusts the required significant range based on the number of means being compared. This makes the LSD test more prone to Type I errors when the number of treatments in the experiment is large.

120. (B) I, II and IV
Applying Duncan's Multiple Range Test involves several systematic steps. First, the treatment means must be arranged in rank order. Next, the standard error of the mean is calculated using the error mean square. Finally, the observed differences between the ranked means are compared against specific significant ranges that vary depending on the distance between the means in the sequence.

121. (B) $LSD = t_{\frac{\alpha}{2}, error_df} \times \sqrt{\frac{2 \times MSE}{r}}$
The mathematical formula for calculating the Least Significant Difference between two treatment means involves several components. It uses the critical t-value for a given level of significance and the error degrees of freedom, multiplied by the standard error of the difference between two means. This standard error is found by taking the square root of twice the error mean square divided by the replications.

122. (B) Repeated t-tests rapidly inflate the family-wise Type I error rate.
Using repeated independent t-tests to compare all pairs of treatment means is statistically problematic because it rapidly inflates the family-wise Type I error rate. As the number of comparisons increases, the probability of finding at least one significant difference by random chance alone becomes much higher than the intended alpha level. Procedures like DMRT are used to control this overall error.

123. (A) Randomization, Replication, and Local Control
The three foundational principles of experimental design established by R.A. Fisher are randomization, replication, and local control. Randomization ensures an unbiased estimate of error, replication provides the means to estimate and reduce that error, and local control improves precision by accounting for known sources of variation. Together, these principles form the basis for valid and efficient agricultural experimentation and analysis.

124. (C) Inherent variation in responses among units treated identically.
Experimental error is formally defined as the inherent variation that exists among experimental units that are treated identically. This variation stems from unmeasurable or uncontrollable factors such as soil heterogeneity or genetic differences between individual plants. It does not refer to researcher mistakes but rather to the random background noise that statistical designs aim to estimate and minimize through replication and control.

125. (D) Isolate known variability sources from error to increase precision.
The principle of local control involves the grouping of homogeneous experimental units into blocks to account for known environmental variability, such as a soil fertility gradient. By isolating this known source of variation from the experimental error, local control increases the precision of the experiment. This ensures that the observed treatment effects are not confounded with existing differences in the experimental field environment.

126. (C) Replication and sample size are statistically synonymous in all designs.
Replication is a core principle that allows for the estimation of experimental error and increases the precision of treatment mean estimates. While it involves increasing the number of observations, replication and sample size are not always statistically synonymous, particularly in complex designs where multiple measurements might be taken from one unit. True replication requires the independent application of treatments to multiple units.

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145. (A) It is highly efficient for experiments with very large treatment counts.
While the Latin Square Design is highly efficient for controlling two-directional variation, its practical application is limited by its strict structural requirements. Because the number of replications must equal the number of treatments, using a large number of treatments would require an unmanageably large and perfectly square experimental area. Therefore, claiming that it is efficient for very large treatment counts is incorrect.

146. (C) LSD is more efficient as it removes variance from two distinct sources.
When an experimental field exhibits significant variation in two perpendicular directions, the Latin Square Design is generally the most efficient choice among the standard designs. This is because it removes the variation from both sources—rows and columns—from the experimental error. Consequently, it often results in a smaller error mean square and higher precision compared to RBD or CRD in such conditions.

147. (A) Totals of the affected row, column, treatment, and the grand total.
Estimating a missing plot value in a Latin Square Design requires using the totals from the affected row, the affected column, and the affected treatment, along with the grand total of the remaining observations. This formula is mathematically derived to minimize the error sum of squares, ensuring that the estimated value provides the most consistent fit within the existing two-way structure.

148. (D) One factor requires larger plots while another requires smaller sub-plots.
The Split-plot design is formally defined as being most appropriate when the experimental factors being studied require different plot sizes. This often occurs due to mechanical or practical constraints, such as when irrigation methods require large areas while fertilizer levels can be applied to smaller sub-units. It allows researchers to combine these factors into a single experiment despite their spatial requirements.

149. (B) Two independent experimental error terms (Error A and Error B).
A distinguishing feature of the Analysis of Variance for a Split-plot design is the presence of two separate and independent experimental error terms. Error A is used to test the significance of the main-plot treatments, while Error B is used to test the sub-plot treatments and the interaction between the two factors. This partitioning reflects the hierarchical nature of the randomization process.

150. (C) Sub-plot treatments have higher precision as Error B is usually smaller.
In a standard Split-plot design, the sub-plot treatments and the interaction effects are typically estimated with higher precision than the main-plot treatments. This is because the sub-plot error variance, or Error B, is generally smaller than the main-plot error variance, or Error A. This occurs because the units within the main-plots are more similar to each other than units across main-plots.

151. (B) P-2, Q-3, R-4, S-1
Degrees of freedom in a Split-plot design are partitioned according to the different levels of the experiment. The main-plot treatment degrees of freedom is a minus one. Error A uses the product of r minus one and a minus one. Sub-plot treatments use b minus one, and Error B uses the product of a and the quantities r minus one and b minus one.

152. (A) Main-plots are randomized in blocks; then sub-plots are randomized within.
The randomization procedure in a Split-plot design follows a strict hierarchical order that reflects the physical layout of the plots. First, the main-plot treatments are randomized within each block or replication. Second, the sub-plot treatments are independently randomized within each of the previously assigned main-plots. This nested randomization is what necessitates the use of two error terms in the final analysis

153. (B) Split-plot design estimates the interaction effect with lower precision.
In a Split-plot design, the interaction between the main-plot and sub-plot factors is tested using the sub-plot error term, which is generally smaller than the main-plot error. Therefore, the interaction effect is estimated with higher precision than the main-plot effect. Consequently, the suggestion that a Split-plot design estimates the interaction with lower precision is incorrect compared to its actual statistical performance.

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154. (B) Binomial dose-response data, such as pesticide toxicity studies.
Probit analysis is a specialized statistical technique primarily used for analyzing dose-response relationships where the outcome is dichotomous, such as mortality or survival. It is widely applied in agricultural toxicology and entomology to determine the effectiveness of pesticides. The method accounts for the sigmoid nature of biological response curves by transforming the data into a form suitable for linear regression analysis.

155. (A) A linear regression line by applying specialized transformations.
The fundamental factual basis of probit analysis is the mathematical transformation of the asymmetrical, sigmoid-shaped dose-mortality curve into a straight linear regression line. This linearization is achieved by converting the percentage mortality into probit values and the dosage into log-dose values. Once the relationship is linear, standard regression techniques can be used to estimate lethal dosages and populations.

156. (C) Adding 5 to avoid handling negative mathematical values.
When calculating probit values, researchers first find the Normal Equivalent Deviate, which corresponds to the mortality proportion in a standard normal distribution. Because NED values can be negative, a constant value of five is added to each deviate by convention to create the final probit value. This shift ensures that all probits are positive, simplifying subsequent manual calculations and statistical reporting in toxicology.

157. (D) The median lethal dose causing death in 50% of the population.
In toxicological research, the LD50 metric represents the median lethal dose of a substance, which is the specific concentration calculated to cause death in fifty percent of the treated population. It serves as a standardized measure for comparing the toxicity of different chemicals or the susceptibility of various insect strains. This value is mathematically determined through the fitted probit regression line.

158. (C) Dosages are transformed to log-dose to normalize tolerance distributions.
In probit regression analysis, the independent variable representing the dosage is typically transformed into its logarithm. This log-dose transformation is used because biological tolerance to chemical substances is often distributed log-normally rather than normally. By using the log of the dose, researchers can linearize the relationship between dose and response, making it compatible with the probit values used for mortality.

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159. (B) He formalized the statistical procedures for biological probit analysis.
D.J. Finney is a significant historical figure in statistics who is directly credited with formalizing the mathematical and computational procedures for probit analysis. His work provided the comprehensive framework needed to apply these techniques to biological and toxicological data. He developed the iterative methods required for calculating the maximum likelihood estimates of the probit regression parameters in scientific research studies.

160. (D) It reflects the variance of the underlying tolerance distribution.
In a fitted probit regression equation, the slope parameter represents the rate of change in probit mortality for each unit increase in log-dose. Statistically, this slope is inversely proportional to the standard deviation of the population's tolerance distribution. A steeper slope indicates a more homogeneous population with less variation in its response to the pesticide, while a flatter slope suggests higher variability.

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